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RADIOLOGICAL HEALTH DATA

MONTHLY REPORT

December 1960

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

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Public Health Service

Division of Radiological Health

PREFACE

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned, among other things, primary responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. Within the Department this responsibility has been delegated to the Division of Radiological Health, Public Health Service.

As a step in the discharge of this responsibility, the Public Health Service is publishing ***Radiological Health Data.*** This publication is issued monthly, with each third issue (starting July 1960) expanded into a quarterly report.

The monthly and quarterly reports are reviewed by a Board of Editorial Advisors with representatives from the following Federal agencies:

Department of Health, Education, and Welfare
Atomic Energy Commission
Department of Defense
Department of Commerce
Department of Agriculture

TABLE OF CONTENTS

	Page
PREFACE	iii
SECTION I.--MILK	
Public Health Service Milk Monitoring Program	1
Radioactivity in Milk (July 1960)	3
Strontium-90 in Bovine Milk from Minnesota--State Department of Health	5
Strontium-90 Content in Canadian Dried Milk Products--Department of National Health and Welfare, Ottawa, Canada	6
Radionuclides in Human Milk--Public Health Service	7
SECTION II.--AIR	
Public Health Service Radiation Surveillance Network	9
Radioactivity of Particulates in Air--Gross Beta Counts (July 1960)	11
Radon and Thoron Measurements (July 1960)	12
Naval Research Laboratory Radioactivity Measurements	12
Daily Record of Fission Product Beta Activity (July 1960)	13
Radioactivity Profile (July 1960)	15
Argonne National Laboratory Air Data (April-June 1960) --Atomic Energy Commission	15
Radionuclide Analysis of Cincinnati Surface Air--Public Health Service	16
SECTION III.--WATER	
Public Health Service National Water Quality Network	17
Radioactivity in Raw Surface Waters (June 1960)	19
Strontium-90 in Tap Water (April-June 1960) Atomic Energy Commission	21
SECTION IV.--OTHER DATA	
External Gamma Activity (July 1960) --Public Health Service Radiation Surveillance Network	22
Strontium-90 Concentration in Bread Purchased in New York City (March-June 1960) -- Atomic Energy Commission	23
Argonne National Laboratory Soil Data (May--June 1960) --Atomic Energy Commission	24
Environmental Levels of Radioactivity at Atomic Energy Commission Installations	24
Argonne National Laboratory, University of Chicago	24
Brookhaven National Laboratory, Associated Universities, Inc	26
Knolls Atomic Power Laboratory, General Electric Company	27
National Reactor Testing Station, Idaho Operations Office, AEC	31
Oak Ridge National Laboratory, Union Carbide Nuclear Company	33
Paducah Atomic Energy Plant, Union Carbide Nuclear Company	39
Savannah River Plant, du Pont Company	41
Shippingport Atomic Power Station, Duquesne Light Company	46
Strontium-90 Content of Animal Fodders--Food and Drug Administration	49
INDEX--Volume I	51

SECTION I.—MILK

PUBLIC HEALTH SERVICE MILK MONITORING PROGRAM

The original Public Health Service Milk Monitoring Program consisted of 12 sampling stations. This is being expanded to include an additional 60 stations, of which 46 submitted samples for July. Since the sampling procedures for the original and the added stations are somewhat different, they will be described and reported separately. The Public Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, continues to conduct the analyses for the original network stations whereas the Public Health Service Southeastern Radiological Health Facility, Montgomery, Alabama, and the Southwestern Radiological Health Facility, Las Vegas, Nevada, provide this service for the added stations.

Publication of the data will normally require a period of about four months after collection due to shipment, processing, decay product build-up, compilation of the data, and inclusion with other radiation data in the monthly reports.

Original Stations

The initial purpose of establishing this network was in keeping with the normal and continuing program of the Department of Health, Education, and Welfare to determine trends in our changing environment, including measurement of amounts of radioactivity in water, air, milk, and other foods. Milk was the food chosen for initial testing because it is among the most important components of the diet and is available at all seasons of the year and in all climates. A primary objective of the project was to develop and simplify methods of collection and radiochemical analysis of milk to make them more suitable for larger scale programs. Since this program has been in operation for over three years, its contribution of information is significant.

The selection of the original sampling stations was based on the following criteria:

1. The milk represented in each sample was from a group of farms milking a total of at least 1,000 cows.

2. The number of individual farms was small enough so that collection of collateral field data from each farm was feasible.

3. The milk samples were from a supply that was part of a metropolitan milkshed.

4. The conditions under which the milk was received were such that each sample was representative of the same farms in the production area.

The Overton, Nevada and St. George, Utah milksheds do not fulfill the 1,000-cow minimum requirement but have been included since they are part of the monitoring program around the Nevada Test Site.

One gallon samples are collected once each month and forwarded by air parcel post to the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, for radionuclide analysis. It is estimated that these samples represent 2,000-gallon lots. The concentration of iodine-131, barium-140, and cesium-137 and naturally occurring potassium-40 are all currently being measured when present in the milk by gamma scintillation spectroscopy. Total strontium and strontium-90 are determined following radiochemical separations, and the strontium-90 is calculated by measuring the build-up of the daughter decay product, yttrium-90 (after about a two week wait) using a low background anticoincidence beta counter. The total radioactive strontium is counted in a shielded internal proportional counter with the strontium-89 calculated as the difference.

A description of the program appears in "The Occurrence of Strontium-90, Iodine-131 and Other Radionuclides in Milk, May 1957 through April 1958," by J. E. Campbell, G. K. Murthy, A. S. Goldin, H. B. Robinson, C. P. Straub, F. J. Weber, and K. H. Lewis, American Journal of Public Health, Vol. 49, No. 2, Feb. 1959, American Public Health Association, reprinted by the Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959.

April through September 1960 issues of Radiological Health Data list references for technical descriptions of the methodology of analyses used.

July data for the original stations are presented in table I.

Added Stations

The Milk Monitoring Program has been expanded to provide additional information on levels of radiation in milk consumed by the public. The new stations are being established in cooperation with State and local health and milk sanitation agencies. The cities have been selected in order to provide adequate coverage from the combined viewpoints of production areas and consuming population. The emphasis on this expanded sampling and radioassay program is that of:

1. Measuring the levels of radionuclides in the milk consumed by the public in various regions of the country by obtaining samples of pasteurized and homogenized milk at the point of distribution to the public.

2. Providing one sampling point within each state with additional points when indicated by widely varying conditions of the milk supply or the need to provide coverage of large population groups. This differs from the original set of sampling stations whose selection was based principally upon certain criteria involving the milk production and milkshed area characteristics.

In some instances the designated points are the same as those which reported originally. The establishment of the added sampling stations does not preclude the need for further samples from the selected milksheds serving the same cities. It is important that both networks be in operation for a sufficient period of time to provide an overlap for purposes of comparative study.

The sampling procedure has been developed to give a sample from one day's sales per month in a community which will be as representative of the total supply as can be achieved under practical conditions. The sample will be a composite of those plants supplying not less than 90% of the city's milk supply. The contribution from each plant to the total sample will be approximately proportional to volume of milk sold.

The samples from the added stations are collected with the assistance of the various State and local health and milk sanitation agencies and shipped for analysis to either the Southwestern or Southeastern Radiological Health Facility. The Southeastern Radiological Health Facility processes samples from the 30 states generally east of the Mississippi, and the Southwestern Radiological Health Facility processes samples from the western states.

At the present time radioassays for Sr^{89}, Sr^{90} and Cs^{137} are being performed. Other radionuclides of concern to public health agencies will be included for assay as necessary for complete monitoring of the milk supply.

The data from the Southwestern Radiological Health Facility and the Southeastern Radiological Health Facility for July 1960 are presented in table II.

TABLE I.--RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program
Robert A. Taft Sanitary Engineering Center

July 1960

(Radioactivity in μμc/liter)

Area	Calcium grams/liter		Iodine-131		Strontium-89		Strontium-90		Barium-140		Cesium-137	
	July	Yearly average	July	Yearly average	July	Yearly average	July	Yearly average	July	Yearly average	July	Yearly average
Atlanta, Ga.	1.10	1.13	ND	<10	ND	< 5	13	15	ND	< 10	30	54
Austin, Tex.	1.03	1.09	ND	<10	ND	< 5	3	5	ND	< 10	10	23
Chicago, Ill.	1.02	1.09	ND	<10	ND	< 5	9	10	ND	<10	30	39
Cincinnati, Ohio	1.01	1.12	ND	<10	ND	< 5	10	11	ND	<10	25	31
New York, N. Y.	1.02	1.07	ND	<10	ND	< 5	10	10	ND	< 10	10	35
Overton, Nev.	0.98	1.08	ND	<10	ND	< 5	2	3	ND	<10	10	17
Sacramento, Calif.	1.02	1.09	ND	< 10	ND	< 5	3	4	ND	<10	10	18
Salt Lake City, Utah	1.05	1.10	ND	<10	ND	< 5	4	7	ND	<10	20	38
Spokane, Wash.	1.03	1.11	ND	<10	ND	< 5	10	12	ND	<10	25	51
St. Louis, Mo.	1.12	1.23	ND	< 10	ND	< 5	16	21	ND	< 10	30	42

Note: Samples are taken at one sampling point from the milk supply of the areas above.
ND--Not detectable by methods used.

TABLE II.--RADIOACTIVITY IN MILK

Public Health Service Milk Monitoring Program

Added Stations--July 1960

(Radioactivity in $\mu\mu$c/liter)

AREA	Calcium grams/liter		Strontium-89		Strontium-90		Cesium-137	
	July	Average to date[1]	July	Average to date[1]	July	Average to date[1]	July	Average to date[1]
Albuquerque, N. M.	1.06	1.20	ND	<5	4	4	-	-
Austin, Tex.	1.04	1.10	ND	<5	2	2	<10	10
Boston, Mass.	0.99	1.15	ND	<5	17	16	30	30
Buffalo, N. Y.	1.12	1.26	ND	<5	10	8	10	10
Burlington, Vt.	0.98	1.16	ND	<5	12	11	20	20
Charleston, W. Va.	1.02	1.16	ND	<5	13	10	10	10
Charlotte, N. C.	1.22	1.14	ND	<5	16	15	10	15
Chicago, Ill.	1.04	1.04	ND	<5	8	8	<10	<10
Cleveland, Ohio	0.94	0.94	ND	<5	9	9	<10	<10
Dallas, Tex.	-	1.35	-	<5	-	8	-	<10
Denver, Colo.	1.04	1.20	ND	<5	5	7	-	-
Des Moines, Iowa	1.08	1.10	ND	<5	8	8	20	20
Detroit, Mich.	1.00	1.00	ND	<5	8	8	<10	<10
Grand Rapids, Mich.	1.18	1.18	ND	<5	10	10	<10	<10
Hartford, Conn.	0.99	1.15	10	<5	6	8	20	20
Helena, Mont.	1.15	1.10	ND	<5	5	7	25	25
Honolulu, Hawaii	1.01	1.10	ND	<5	4	4	40	40
Idaho Falls, Idaha	1.15	1.00	ND	<5	5	6	-	-
Indianopolis, Ind.	1.10	1.10	ND	<5	6	6	<10	<10
Kansas City, Mo.	1.06	1.10	ND	<5	6	8	-	-
Laramie, Wyo.	1.02	1.10	ND	<5	3	5	-	-
Las Vegas, Nev.	1.04	1.10	ND	<5	3	3	-	-
Louisville, Ky.	0.97	1.17	5	<5	10	8	<10	<10
Manchester, N. H.	1.00	1.24	ND	<5	14	14	40	40
Milwaukie, Wis.	1.06	1.06	ND	<5	8	8	<10	<10
New Orleans, La.	1.08	1.08	ND	<5	18	18	10	10
New York, N. Y.	0.96	1.10	ND	<5	12	12	10	15
Norfolk, Va.	1.07	1.07	ND	<5	10	10	<10	<10
Oklahoma City, Okla.	1.10	1.10	ND	<5	8	8	<10	<10
Palmer, Alaska	1.16	1.16	ND	<5	5	6	30	30
Philadelphia, Pa.	1.07	1.16	ND	<5	11	10	10	20
Phoenix, Ariz.	1.02	1.02	ND	<5	5	5	15	15
Pittsburgh, Pa.	1.18	1.23	ND	<5	16	15	10	15
Portland, Me.	0.99	1.10	ND	<5	16	16	30	35
Portland, Ore.	1.12	1.10	ND	<5	11	11	70	70
Providence, R. I.	0.98	1.14	ND	<5	14	16	20	20
Salt Lake City, Utah	1.07	1.10	ND	<5	3	7	-	-
San Francisco, Calif.	1.11	1.10	ND	<5	5	6	20	20
San Juan, P. R.	1.06	1.06	ND	<5	4	4	<10	<10
Seattle, Wash.	1.10	1.10	ND	<5	7	9	60	60
Spokane, Wash.	1.16	1.10	ND	<5	7	9	-	-
Syracuse, N. Y.	1.18	1.26	ND	<5	8	8	10	15
Trenton, N. J.	1.10	1.18	ND	<5	8	9	<10	10
Washington, D. C.	1.06	1.06	ND	<5	10	10	10	10
Wichita, Kans.	1.02	1.10	ND	<5	4	6	-	-
Wilmington, Del.	0.99	1.12	ND	<5	10	10	<10	20

ND--Not detectable by methods used.

[1]Because this program was initiated in 1960 and sampling stations necessarily become operative in a staggered sequence, the averages shown represent all samples taken to date. Averages will normally be for the latest 12 month period after sampling began. For the July data, the average covers a period from one to four months.

STRONTIUM-90 IN BOVINE MILK FROM MINNESOTA

Division of Environmental Sanitation
Minnesota Department of Health

The Minnesota State Department of Health, Division of Environmental Sanitation, initiated a small bovine milk surveillance network in September 1958. Two-ounce samples, collected daily at each of the network stations, are composited and analyzed monthly. Collection is made at the bottling machines so that the sample is randomly representative of the milk produced in that milkshed.

Data for the initial station for the period September 1958 through August 1959 were averaged in the April 1960 issue of Radiological Health Data. Detailed results for the period September 1958 through December 1959 were published in the July 1960 Quarterly Report. The most recently reported data from this network, with Rochester replacing the original station at Faribault, are presented below.

TABLE 1.--STRONTIUM-90 IN BOVINE MILK FROM MINNESOTA

January-April 1960

(Radioactivity in $\mu\mu$c/liter)

Month	Brainerd	Duluth	Minneapolis	Thief River Falls	Worthington	Rochester
January.....	-	16.3	9.0	10.0	5.9	5.6
February.....	22.1	16.8	6.8	11.5	6.1	9.3
March.....	13.4	16.1	7.6	8.9	9.5	5.9
April.....	17.8	16.6	7.0	12.4	11.0	8.8

STRONTIUM-90 IN CANADIAN DRIED MILK PRODUCTS

The following table presents the results of measurements of strontium-90 in Canadian dried milk for the months of April, May and June 1960. This table was included in the "Quarterly Report of the Radioactive Fallout Study Program," dated September 1960, published by the Radiation Protection Division of the Department of National Health and Welfare, Ottawa, Canada. Figure 1 shows the sampling locations.

Data for the months of January, February and March 1960 were published in the September issue of Radiological Health Data.

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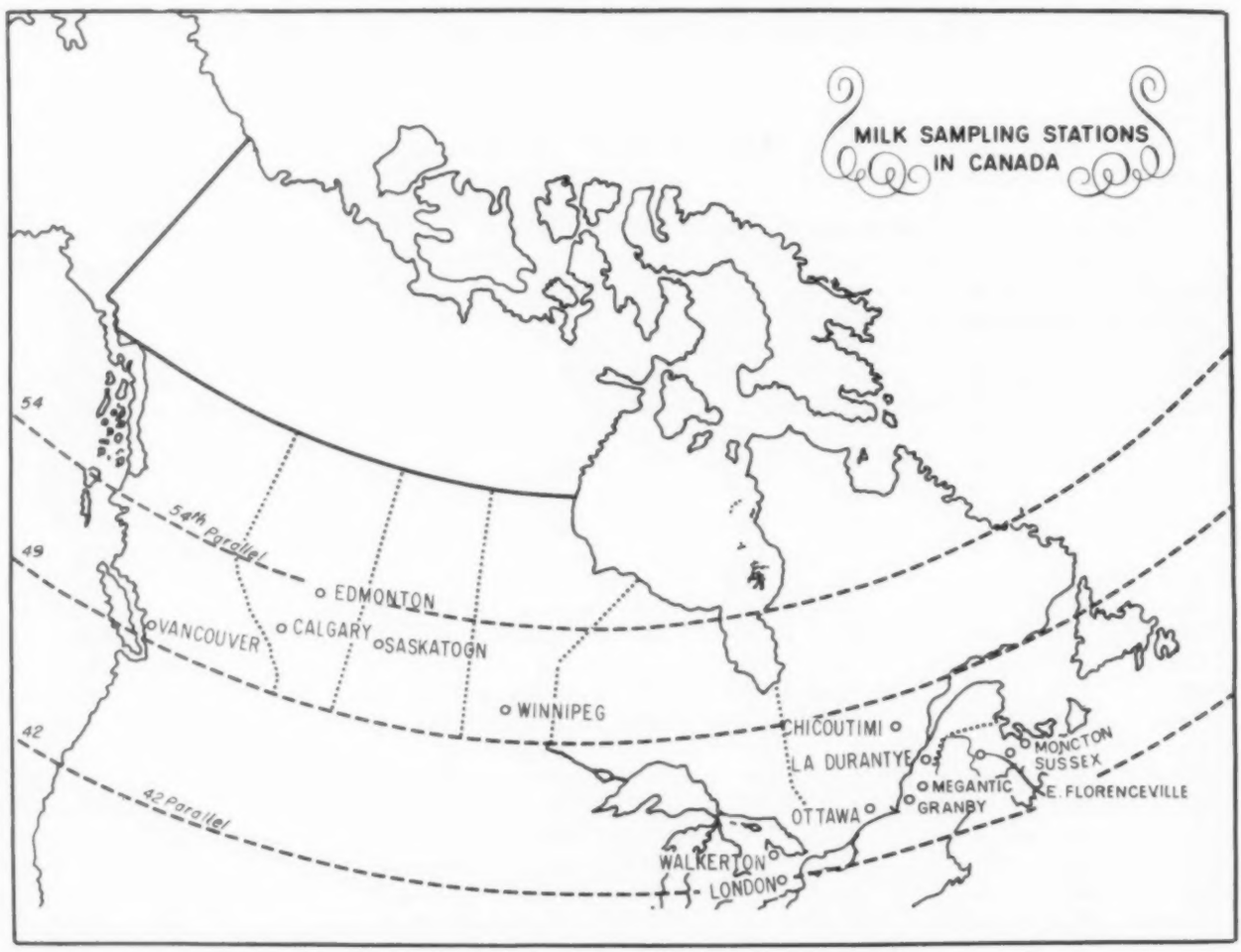


FIGURE 1

TABLE 1.—STRONTIUM-90 CONTENT OF CANADIAN DRIED MILK POWDER SAMPLES

(Concentrations in $\mu\mu$c/gm calcium)

Station	April 1960	May 1960	June 1960
Vancouver[1]	14.3	13.4	13.6
Edmonton[1]	15.9	10.3	4.0
Calgary	14.3	14.8	9.3
Saskatoon[2]	13.3	15.6	6.4
Winnipeg[2]	12.0	11.5	[3]N.S.
Walkerton	5.4	5.8	5.4
London[1]	6.9	5.2	4.5
Ottawa[1]	9.2	7.7	5.3
Granby[1]	19.3	21.9	11.7
Megantic	24.7	26.2	16.7
La Durantye	20.5	19.1	12.2
Chicoutimi	18.8	19.3	N.S.
Moncton[1, 2]	13.0	10.7	11.0
Sussex	14.7	13.8	9.9
E. Florenceville	16.9	19.9	12.0
Charlottetown	N.S.	N.S.	N.S.
Average	14.6	14.3	9.4

[1] Natural strontium determinations made for these stations. All other stations were corrected for natural strontium using an average factor of 1.06.

[2] Buttermilk sample. All other samples are skim milk.

[3] N.S.—No milk powder manufactured for the month

Note: Samples collected by Inspectors of the Marketing Division, Department of Agriculture.

RADIONUCLIDES IN HUMAN MILK

Division of Radiological Health
Public Health Service

The Fitzsimmons General Hospital, Denver, Colorado; the United States Army Hospital, Fort Carson, Colorado and the Chicago Board of Health are cooperating with the Division of Radiological Health, Public Health Service in the collection of human milk samples. The object of the project is to determine the relative concentration of strontium-90 and other radionuclides in human milk from selected geographical areas.

The project was begun in Colorado in July 1959 and expanded to include Chicago in December 1959. The samples are collected daily for a monthly composite. The analyses are conducted by the Publ[illegible] Health Service Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

Table 1 presents the data from the beginning of the project through June 1960.

TABLE 1.--RADIONUCLIDES IN HUMAN MILK

Sample	Date received	Ca	K	Sr^{89}	Sr^{90}	I^{131}	Ba^{140}	Cs^{137}
		gm/liter		$\mu\mu$c/liter				
Colorado								
CO-1.....	7/9/59	0.185	0.552	ND	0.7±0.3	-	-	10.8±1.3
CO-2.....	7/17/59	0.220	0.561	ND	0.7±0.3	-	-	-
CO-3.....	11/5/59	0.212	0.664	ND	0.2±0.2	-	-	-
CO-4.....	11/16/59	0.227	0.643	ND	0.4±0.3	ND	ND	20
CO-5.....	11/27/59	0.293	0.618	ND	0.4±0.3	ND	ND	15
CO-6.....	12/16/59	0.277	0.712	ND	0.6±0.2	ND	ND	15
CO-7.....	1/8/60	0.277	0.707	ND	0.5±0.2	ND	ND	5
CO-8.....	1/18/60	0.358	0.777	ND	0.6±0.2	ND	ND	15
CO-9.....	1/19/60	0.183	0.630	ND	0.6±0.2	ND	ND	15
CO-10.....	3/14/60	0.252	0.674	ND	0.7±0.2	ND	ND	ND
CO-11.....	3/16/60	0.218	0.658	ND	0.8±0.2	ND	ND	ND
CO-12.....	5/6/60	0.198	0.508	ND	0.8±0.2	ND	ND	20
Chicago								
CH-1.....	12/21/59	0.293	0.508	ND	0.6±0.2	ND	ND	5
CH-2.....	12/29/59	0.198	0.329	ND	0.4±0.1	ND	ND	10
CH-3.....	1/25/60	0.191	0.534	ND	0.3±0.1	ND	ND	10
CH-4.....	5/19/60	0.190	0.344	ND	1.4±0.4	ND	ND	ND
CH-5.....	6/13/60	0.231	0.251	ND	0.6±0.2	ND	ND	10

ND--Not detectable.
Note: I^{131}, Ba^{140}, Cs^{137} values by gamma spectroscopy except Cs^{137} for Sample CO-1.

SECTION II.—AIR

PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK

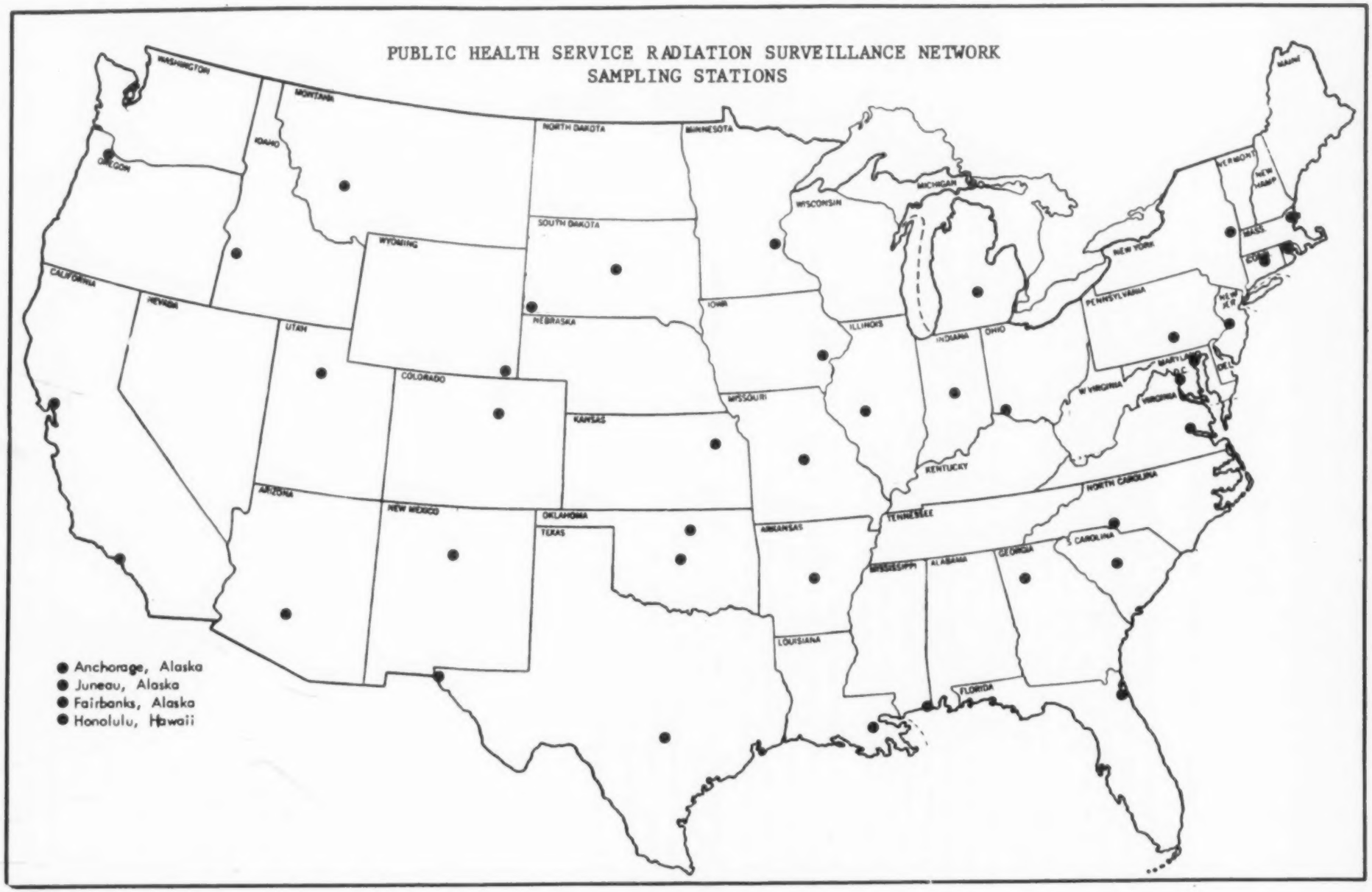
The Public Health Service Radiation Surveillance Network was established in 1956 in cooperation with the Atomic Energy Commission to provide a means of promptly determining increases in environmental radiation due to radioactive fallout from nuclear weapons tests. Although no nuclear tests have been conducted by the United States since 1958, the program has proven sufficiently valuable that it has been extended to a round-the-year basis and currently consists of 45 stations at urban locations (see figure 1) operated by State and local health department personnel with 2 stations operated by U. S. Public Health Service personnel.

Measurements of gross beta radioactivity in air have been taken since they provide one of the earliest and most sensitive indications of increases of activity in the environment, and thus act as an "alert" system. A direct evaluation of biological hazards is not possible from these data alone. However, field measurements do enable the operator to estimate the amount of beta activity of particulates in the air at the station five hours after collection, by comparison to a know source, using a portable survey meter. The filters are then forwarded to a laboratory in Washington, D. C. for a more refined measurement using a thin window proportional counter.

Air samplers are in operation at the 45 stations on an average of 70 percent of the week. Air is drawn through a cellulose carbon loaded dust filter using a high volume air sampler. The radioactive material in fallout adhering to small dust-like particles is retained on the filter. Some gaseous fission products are adsorbed by the carbon. The contribution by gaseous fission products has represented only a small part of the total beta activity in these samples.

About 85 percent of the stations collect samples of precipitation which are sent to Washington, D. C. for analysis. Values are now below limits of detection by present instrumentation. New equipment is being procured to measure lower values. Measurements have indicated that the bulk of deposited activity occurs through precipitation but concentrations in surface air are not directly relatable to the amount deposited through precipitation.

Table 1 presents a summary of the data for July 1960.


PUBLIC HEALTH SERVICE RADIATION SURVEILLANCE NETWORK
SAMPLING STATIONS
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
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ALABAMA
GEORGIA
FLORIDA
S. CAROLINA
NORTH CAROLINA
VIRGINIA
W. VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
VERMONT
NEW HAMP.
MASS.
MARYLAND
D.C.
DEL.
N.J.
Anchorage, Alaska
Juneau, Alaska
Fairbanks, Alaska
Honolulu, Hawaii

FIGURE 1

TABLE 1.—RADIOACTIVITY OF PARTICULATES IN AIR - GROSS BETA COUNTS

Public Health Service Radiation Surveillance Network

July 1960

Station location	Weighted average $\mu\mu c/m^3$	Maximum $\mu\mu c/m^3$	Minimum $\mu\mu c/m^3$
Alaska, Anchorage	< 0.10	0.14	< 0.10
Alaska, Fairbanks	< 0.11	0.18	< 0.10
Alaska, Juneau	< 0.10	< 0.10	< 0.10
Arizona, Phoenix	< 0.14	0.18	< 0.10
Arkansas, Little Rock	< 0.12	0.20	< 0.10
California, Berkeley	< 0.10	< 0.10	< 0.10
California, Los Angeles	< 0.10	0.12	< 0.10
Colorado, Denver	< 0.14	0.25	< 0.10
Connecticut, Hartford	< 0.14	0.32	< 0.10
District of Columbia	< 0.17	0.31	< 0.10
Florida, Jacksonville	< 0.10	0.11	< 0.10
Georgia, Atlanta	< 0.13	0.22	< 0.10
Hawaii, Honolulu	< 0.10	< 0.10	< 0.10
Idaho, Boise	0.18	0.23	0.17
Illinois, Springfield	< 0.18	0.43	< 0.10
Indiana, Indianapolis	< 0.13	0.20	< 0.10
Iowa, Iowa City	< 0.14	0.20	< 0.10
Kansas, Topeka	< 0.12	0.18	< 0.10
Louisiana, New Orleans	< 0.10	0.10	< 0.10
Maryland, Baltimore	< 0.16	0.25	< 0.10
Massachusetts, Lawrence	< 0.11	0.18	< 0.10
Michigan, Lansing	< 0.12	0.19	< 0.10
Minnesota, Minneapolis	< 0.12	0.16	< 0.10
Mississippi, Pascagoula	< 0.12	0.38	< 0.10
Missouri, Jefferson City	< 0.12	0.17	< 0.10
Montana, Helena	< 0.15	0.22	< 0.10
New Jersey, Trenton	< 0.12	0.27	< 0.10
New Mexico, Santa Fe	< 0.12	0.15	< 0.10
New York, Albany	< 0.12	0.23	< 0.10
North Carolina, Gastonia	< 0.14	0.24	< 0.10
Ohio, Cincinnati	0.78	2.80	0.10
Oklahoma, Oklahoma City	< 0.12	0.20	< 0.10
Oklahoma, Ponca City	< 0.10	0.12	< 0.10
Oregon, Portland	< 0.13	0.23	< 0.10
Pennsylvania, Harrisburg	< 0.15	0.23	< 0.10
Rhode Island, Providence	< 0.15	0.23	< 0.10
South Carolina, Columbia	< 0.12	0.22	< 0.10
South Dakota, Edgemont	-	-	-
South Dakota, Pierre	0.19	0.24	0.13
Texas, Austin	< 0.10	< 0.10	< 0.10
Texas, El Paso	< 0.15	0.34	< 0.10
Utah, Salt Lake City	< 0.13	0.20	< 0.10
Virginia, Richmond	< 0.13	0.18	< 0.10
Washington, Seattle	< 0.10	0.16	< 0.10
Wyoming, Cheyenne	< 0.11	0.15	< 0.10

Values for beta activities in air in Cincinnati are somewhat higher than in other stations in the Radiation Surveillance Network. Reasons may be:

1. Cincinnati uses a membrane type filter with a 20 liters per minute flow rate, compared to a cellulose type filter at other stations sampling 1,500 liters per minute.
2. Variations in counting equipment.
3. Samples are counted at Cincinnati within one day after collection, whereas the samples from other stations are counted several days later in Washington. Thus, Cincinnati values may incorporate natural beta activity from thoron daughters.

Although the relative contribution from each of these parameters has yet to be evaluated, it is recognized that some of them probably play a much more significant role than others.

TABLE 2.–RADON AND THORON MEASUREMENTS

Public Health Service Radiation Surveillance Network Station at Cincinnati, Ohio

July 1960

Date	Continuous Sample Collection			Radon[(a)] PM $\mu\mu c/m^3$	Radon[(b)] AM $\mu\mu c/m^3$	Thoron[(c)] $\mu\mu c/m^3$	Beta[(d)] activity $\mu\mu c/m^3$
	Sample change time	Sampling period (hours)	Volume m^3				
July 1.....	0817	23.8	28.7	(e)	(e)	(e)	0.3
5.....	1030	98.2	116.7	66	155	3.4	0.4
6.....	0810	21.6	25.8	111	523	4.5	1.8
7.....	0808	23.9	29.0	106	435	3.8	1.2
8.....	0814	24.0	28.9	134	862	7.2	0.1 (3)
11.....	0808	71.9	85.0	136	367	2.8	0.5
12.....	0820	24.1	28.6	192	903	5.8	2.0
13.....	0811	23.8	28.3	219	738	8.3	2.8
14.....	0815	24.0	28.4	57	100	1.4	0.5
15.....	0815	23.9	28.5	58	440	2.9	0.2 (3)
18.....	0815	71.9	85.0	210	798	8.6	0.9
19.....	0815	23.9	28.1	151	648	6.5	2.1
20.....	0830	24.2	27.9	158	451	5.1	2.0
21.....	0825	23.9	28.5	77	326	4.4	1.3
22.....	0820	23.9	29.1	199	720	9.5	0.4 (3)
25.....	0816	71.9	86.7	190	763	7.4	0.4
26.....	0815	23.9	29.1	131	465	5.3	0.7
27.....	0817	24.0	29.2	115	293	2.2	0.7
28.....	0817	23.9	29.1	182	595	4.0	1.3
29.....	0815	23.9	27.5	166	962	7.5	0.2 (3)
	Average			140	612	5.7	0.8

(a) Filters are temporarily withdrawn from sampler at about 3 p.m. and counted. (Values are corrected back to removal time.) The filters are then replaced on sampler to complete the sampling period of about 24 hours. Thus, the values in this column are from the same filters that are counted at about 8 A.M. the following day.

(b) Measured within a few minutes of removal of filter from sampler and corrected back to collection time (uncorrected for thoron daughter interference).

(c) Thoron from alpha activity of filter sample counted 7 hours after taking a 24-96 hour sample.

(d) Gross beta activity when counted one day after end of sampling or later as indicated by numeral in parenthesis.

(e) Counter out of order during this period.

NAVAL RESEARCH LABORATORY RADIOACTIVITY MEASUREMENTS

Radioactivity measurements of air-filter samples collected at various sites along the 80th Meridian (West) are made by the U. S. Naval Research Laboratory under a program partially financed by the Atomic Energy Commission.

The daily record of fission product beta activity during July 1960 is shown in table 1, while the radioactivity profile for the same month is shown in Figure 1. All radioactivity concentrations are given in disintegrations per minute per cubic meter of air at the collecting site. (2.2 disintegrations per minute per cubic meter equals 1 micromicrocurie per cubic meter).

TABLE 1.—DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION

U. S. Naval Research Laboratory

July 1960

(Disintegrations/minute per cubic meter of air)

Day	Punta Arenas, Chile	Puerto Montt, Chile	Santiago, Chile	Antofagasta, Chile	Chacaltaya, Bolivia	Lima, Peru	Guayaquil, Ecuador
1	-	0.02	0.07	0.10	0.05	0.01	0.02
2	-	0.03	0.04	0.07	0.05	0.04	0.02
3	-	0.03	0.04	0.07	0.05	0.04	0.02
4	-	0.03	0.04	0.07	0.05	0.04	0.07
5	-	0.03	0.03	0.08	0.07	0.04	0.07
6	-	0.03	0.03	0.08	0.07	0.04	0.07
7	-	0.03	0.11	0.07	0.07	0.02	0.07
8	-	0.03	0.11	0.07	0.07	0.02	0.05
9	-	0.02	0.11	0.09	0.04	0.01	-
10	-	0.02	0.11	0.09	0.04	0.01	-
11	-	0.02	0.11	0.09	0.04	0.01	-
12	-	0.03	0.09	0.14	0.06	0.04	-
13	-	0.03	0.09	0.14	0.06	0.04	-
14	-	0.03	0.08	0.09	0.03	0.06	-
15	-	0.03	0.08	0.09	0.03	0.06	-
16	-	0.03	0.09	0.05	0.03	0.05	-
17	-	0.03	0.09	0.05	0.03	0.05	-
18	-	0.03	0.09	0.05	0.05	0.05	-
19	-	0.00	-	0.14	0.05	0.01	-
20	-	0.00	-	0.14	0.05	0.01	-
21	-	0.02	-	0.15	0.03	0.06	-
22	-	0.02	-	0.15	0.03	0.06	-
23	-	0.04	-	0.11	0.04	0.01	-
24	-	0.04	-	0.11	0.04	0.01	-
25	-	0.04	-	0.11	0.04	0.01	-
26	-	0.02	-	0.09	0.04	0.10	-
27	-	0.02	-	0.09	0.04	0.10	-
28	-	0.01	-	0.07	0.06	0.03	-
29	-	0.01	-	0.07	0.06	0.03	-
30	-	0.01	-	0.07	0.07	0.09	-
31	-	0.01	-	0.07	0.07	0.09	-
Mean value	-	0.02	0.08	0.09	0.05	0.04	-

TABLE 1.--DAILY RECORD OF FISSION PRODUCT β-ACTIVITY COLLECTED BY AIR FILTRATION--Con.

U. S. Naval Research Laboratory

July 1960

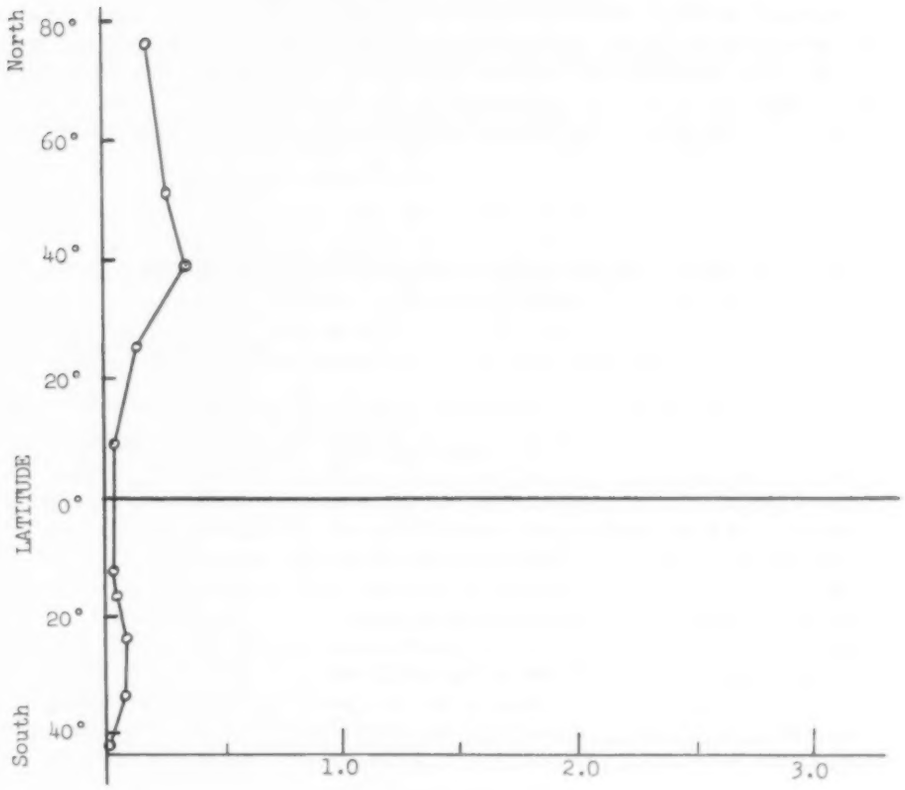
(Disintegrations/minute per cubic meter of air)

Day	Mira-flores, Panama Canal	Mauna Loa, Hawaii	Miami, Florida	Washing-ton, D. C.	Moosonee, Ontario, Canada	Thule Green-land	Bravo, Artic Ice Floe
1	0.06	0.64	0.22	0.55	0.34	0.17	0.02
2	0.08	0.71	0.18	0.29	0.23	0.17	0.02
3	0.08	0.71	0.18	0.29	0.23	0.17	0.02
4	0.08	0.71	0.18	0.29	0.23	0.17	0.02
5	0.07	0.35	0.16	0.53	0.12	0.18	0.03
6	0.04	0.35	0.16	0.53	0.12	0.18	0.03
7	0.04	0.22	0.19	0.37	0.47	0.20	0.03
8	0.04	0.22	0.19	0.37	0.47	0.20	0.03
9	0.08	0.17	0.10	0.14	0.36	0.08	0.03
10	0.08	0.17	0.10	0.14	0.36	0.08	0.03
11	0.08	0.17	0.10	0.14	0.36	0.08	0.03
12	0.09	0.19	0.16	0.48	0.20	0.18	0.04
13	0.09	0.19	0.16	0.48	0.20	0.18	0.04
14	0.05	0.12	0.14	0.23	0.24	0.29	0.04
15	0.05	0.12	0.14	0.23	0.24	0.29	0.04
16	0.03	0.16	0.22	0.36	0.32	0.25	0.04
17	0.03	0.16	0.22	0.36	0.32	0.25	0.04
18	0.03	0.16	0.10	0.36	0.32	0.25	0.04
19	0.07	0.12	0.10	0.50	0.14	0.25	-
20	0.07	0.12	0.10	0.50	0.14	0.25	-
21	0.03	0.22	0.19	0.22	0.29	0.17	-
22	0.03	0.22	0.19	0.22	0.29	0.17	-
23	0.05	0.15	0.09	0.27	0.29	0.17	-
24	0.05	0.15	0.09	0.27	0.29	0.17	-
25	0.05	0.15	0.09	0.27	0.29	0.17	-
26	0.05	0.07	0.03	0.35	0.12	0.10	-
27	0.05	0.07	0.03	0.35	0.12	0.10	-
28	0.02	0.03	0.03	0.35	0.34	0.10	-
29	0.02	0.03	0.03	0.35	0.34	0.10	-
30	0.03	0.09	0.07	0.37	0.26	0.10	
31	0.03	0.09	0.07	0.37	0.26	0.54	-
Mean value	0.05	0.23	0.13	0.34	0.27	0.18	0.03

AVERAGE MEASUREMENTS OF SURFACE AIR
AT STATIONS ALONG THE 80TH MERIDIAN (WEST)

U. S. Naval Research Laboratory

July 1960



AVERAGE FISSION PRODUCT CONCENTRATION (d/m per Cubic Meter of Air)

FIGURE 1

ARGONNE NATIONAL LABORATORY AIR DATA

U. S. Atomic Energy Commission

Air filter measurements of ground level air at Argonne National Laboratory, Lemont, Illinois, for September 1959 through March 1960 were reported in the August 1960 issue of Radiological Health Data. The table below gives the cesium-137 activity for the second quarter of 1960. Other fission products, rhodium-102 and tungsten-185 showed similar trends. The peak concentrations appear in April 1960. These data were reported to the Atomic Energy Commission by Dr. Philip F. Gustafson.

TABLE 1.--AIR CONCENTRATION OF CESIUM-137
AT ARGONNE NATIONAL LABORATORY

Second Quarter 1960

Month	Activity $\mu\mu c/m^3$
April.....	4.8×10^{-3}
May.....	3.7×10^{-3}
June.....	2.9×10^{-3}

RADIONUCLIDE ANALYSIS OF CINCINNATI SURFACE AIR

Analyses have been performed at the Robert A. Taft Sanitary Engineering Center in Cincinnati, Ohio, to determine specific radionuclide content of the air in that area for the period of the second week in February 1959 through May 1959. The analyses[1] were conducted by processing one composite sample of 83 millipore filters used by the Cincinnati station of the Public Health Service Radiation Surveillance Network for collecting 24 hour daily air samples. The entire ashed sample was analyzed by gamma spectroscopy for identification of the gamma emitting radionuclides. An aliquot was then taken for radiochemical analyses. The radionuclide content of the ash, as analyzed and correlated to the total volume of air drawn through the filters, is presented in the following table. The data show that cerium-141/144, zirconium-95 and ruthenium-103/106 comprised most of the activity in this composite of Cincinnati surface air.

TABLE 1.--RADIONUCLIDE CONTENT OF CINCINNATI SURFACE AIR

Nuclide	Activity pc/m^3	Critical organ
Strontium-89	0.18	Bone; Lung
Strontium-90	0.04	Bone
Cesium-137	0.26	Lung
Zirconium-95 (not including Niobium-95)	0.64	Lung
Ruthenium-103/106 (including Rhodium-103/106)	0.50	Lung
Cerium-141/144 (including praseodymium-144)	1.44	Lung
Trivalent Rare Earths (not including yttrium)	0.14	Bone
Zinc-65	0.04	Lung
Cobalt-60	0.16	Lung
Mangances-54	<0.04	Lung

[1]Chemical procedures are presented in the complete report entitled "Radionuclide Analysis of Cincinnati Air," dated September 26, 1960, by R. J. Velton and H. L. Kreiger, Robert A. Taft Sanitary Engineering Center, Public Health Service, Cincinnati, Ohio.

SECTION III.—WATER

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK

The National Water Quality Network was established under the provision of Section 4 (c) of Public Law 660, which states "...The Surgeon General shall ... collect and disseminate basic data ... (relating) to water pollution and the prevention and control thereof."

This Network, operated in cooperation with State local health agencies, was started in October 1957. At present there are 75 sampling stations located on major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and for agricultural, industrial and other uses; some of these stations are interstate, coastal, and International Boundary waters, and waters on which activities of the Federal Government may have an impact. Ultimately a total of 250 to 300 stations will be operated. A few of the more recently established stations have not yet begun to report radioactivity.

Samples of water are examined for chemical, physical, and biological quality insofar as these relate to pollution. Samples for some determinations are taken weekly, others monthly, and for some continuous composite samples of 10 to 15 days are obtained.

Gross alpha and beta measurements are made on both suspended and dissolved solids in the raw surface water samples. The radioactivity levels of dissolved solids provide a rough measure of the levels which may be found in a treated water, where such water treatment removes substantially all of the suspended matter. Naturally occurring radioactive substances in the environment are the source of essentially all of the alpha activity. The contamination of the environment from man-made sources is the major contributor to the beta activity. It should be noted that with the cessation of weapons testing, beta activity in most raw waters is generally approaching a level attributable solely to natural beta activity. Natural beta activity can be two or three times the natural alpha activity based on the same nuclides being present. Some exceptions to this are seen, notably the data for the Columbia River and the Animas River. The results are reported in micromicrocuries per liter, and are shown for each station on a given river.

While beta determinations for the first two years of the Network operation have been done on each sample weekly, the alpha determinations are reported generally on a composite sample of more than one week. Beginning with samples taken in January 1960, beta determinations were performed on composite samples obtained by combining two weekly samples. The alpha data will be reported on three-month composite samples, with 1/3 of the stations being covered each month. All the data reported below represent the average of all information available for the month indicated.

Strontium-90 data are reported as being the results of determinations on composite samples for a three-month period ending in the month shown.

Additional information and data may be obtained from the following sources:

1. "National Water Quality Network Annual Compilation of Data," PHS Publication. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.50.

2. "Report on National Water Quality Control Network," submitted by Dr. F. J. Weber, Chief, Division of Radiological Health, PHS, to Joint Committee on Atomic Energy Hearings on Fallout from Nuclear Weapons Tests, Vol. 1, May 1959, pages 167-169.

PUBLIC HEALTH SERVICE NATIONAL WATER QUALITY NETWORK
SAMPLING STATIONS

As of June 30, 1960

FIGURE 1

TABLE I.—RADIOACTIVITY IN RAW SURFACE WATERS

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending 6/30/60	June, 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
ANIMAS RIVER							
Cedar Hill, N. Mex.	0.3	10	2	12	6	2	8
ARKANSAS RIVER							
Coolidge, Kans.	1.1	-	-	-	-	-	-
Ponca City, Okla.	1.3	6	0	6	11	2	13
Fort Smith, Ark.	1.1	41	4	45	11	2	13
Pendleton Ferry, Ark.	1.2	21	0	21	14	0	14
CHATTAHOOCHIE RIVER							
Atlanta, Ga.	(*)	0	0	0	0	0	0
Columbia, Ga.	0.5	0	1	1	0	0	0
COLORADO RIVER							
Loma, Colo.	0.3	8	0	8	5	3	8
Page, Ariz.	0.9	18	0	18	10	3	13
Hoover Dam, Ariz.-Nev.	1.3	0	0	0	0	4	4
Parker Dam, Ariz.-Calif.	0.4	0	0	0	<1	5	6
Yuma, Ariz.	1.0	0	0	0	2	2	4
COLUMBIA RIVER							
Pasco, Wash.	0.3	22	156	178	0	0	0
Wenatchee, Wash.	0.3	0	0	0	0	0	0
Bonneville Dam, Ore.	(*)	8	69	77	-	-	-
Clatskanie, Ore.	0.3	-	-	-	-	-	-
CONNECTICUT RIVER							
Northfield, Mass.	(*)	0	0	0	0	0	0
DELAWARE RIVER							
Martin's Creek, Pa.	0.4	0	3	3	0	0	0
Philadelphia, Pa.	0.3	1	0	1	6	0	6
GREAT LAKES							
Duluth, Minn.	0.3	0	0	0	0	0	0
Detroit, Mich.	0.6	0	0	0	0	1	1
Buffalo, N. Y.	0.7	0	2	2	0	0	0
HUDSON RIVER							
Poughkeepsie, N. Y.	0.7	<1	1	2	1	0	1
ILLINOIS RIVER							
Peoria, Ill.	0.8	0	0	0	<1	1	2
KANAWHA RIVER							
Winfield Dam, W. Va.	0.3	0	0	0	0	<1	<1
MISSISSIPPI RIVER							
Red Wing, Minn.	1.5	1	0	1	0	1	1
Dubuque, Iowa	(*)	0	6	6	0	0	0

TABLE I.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending 6/30/60	June 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
MISSISSIPPI RIVER—Con.							
Burlington, Iowa	(*)	20	24	41	4	1	5
East St. Louis, Ill.	1.2	12	4	16	5	0	5
Cape Girardeau, Mo.	0.9	32	17	49	17	1	18
West Memphis, Ark.	0.9	6	6	12	7	0	7
Delta, La.	(*)	0	0	0	5	2	7
New Orleans, La.	1.0	12	6	18	8	1	9
MISSOURI RIVER							
Williston, N. D.	0.7	7	6	13	5	2	7
Bismarck, N. D.	0.9	0	3	3	0	5	5
Yankton, S. D.	1.0	0	4	4	0	1	1
Omaha, Nebr.	0.6	20	14	34	0	5	5
St. Joseph, Mo.	0.9	-	-	-	-	-	-
Kansas City, Kans.	0.9	49	0	49	17	0	17
St. Louis, Mo.	1.0	58	9	67	12	2	14
OHIO RIVER							
East Liverpool, O.	1.9	0	0	0	0	0	0
Wheeling, W. Va.	-	10	10	20	0	0	0
Huntington, W. Va.	0.3	6	8	14	1	0	1
Cincinnati, O.	0.6	4	3	7	0	0	0
Evansville, Ind.	0.4	27	0	27	-	-	-
Cairo, Ill.	0.7	0	32	32	0	1	1
POTOMAC RIVER							
Williamsport, Md.	0.8	0	0	0	0	1	1
Great Falls, Md.	0.5	0	16	16	2	0	2
RED RIVER							
Denison, Tex.	1.2	0	0	0	0	0	0
Index, Ark.	1.2	4	25	29	4	1	5
Alexandria, La.	0.7	19	20	39	8	2	10
RIO GRANDE RIVER							
El Paso, Tex.	1.4	28	0	28	0	0	0
Laredo, Tex.	1.0	0	0	0	0	4	4
Brownsville, Tex.	0.7	0	0	0	-	-	-
SABINE RIVER							
Ruliff, Tex.	(*)	3	0	3	<1	<1	<1
ST. CLAIR RIVER							
Port Huron, Mich.	(*)	<1	1	1	0	1	1
ST. LAWRENCE RIVER							
Massena, N. Y.	0.6	0	4	4	0	0	0

TABLE I.—RADIOACTIVITY IN RAW SURFACE WATERS—Con.

Public Health Service National Water Quality Network

(Micromicrocuries per liter)

Station	Quarter ending 6/30/60	June 1960					
	Strontium-90	Beta activity			Alpha activity		
		Susp.	Diss.	Total	Susp.	Diss.	Total
ST. MARY'S RIVER							
Sault Ste. Marie, Mich.	1.	0	<1	<1	0	0	0
SCHUYLKILL RIVER							
Philadelphia, Pa.	0.7	0	0	0	<1	0	<1
SAVANNAH RIVER							
Port Wentworth, Ga.	0.8	<1	2	3	-	-	-
SNAKE RIVER							
Wawawai, Wash.	0.3	0	2	2	0	0	0
Weiser, Idaho	0.5	0	0	0	-	-	-
SUSQUEHANNA RIVER							
Sayre, Pa.	0.4	0	8	8	0	<1	<1
Conowingo, Md.	0.2	1	1	2	<1	0	<1
TENNESSEE RIVER							
Chattanooga, Tenn.	1.3	0	16	16	0	0	0
YELLOWSTONE RIVER							
Sidney, Mont.	0.3	18	2	20	5	3	8

*Insufficient sample for analysis.

STRONTIUM-90 IN TAP WATER

The Atomic Energy Commission's Health and Safety Laboratory monitors the tap water for Richmond, California and New York City for strontium-90 on a monthly basis. The data for the second quarter are presented below. Data for the first quarter were given in the August 1960 issue of Radiological Health Data.

TABLE 2.—STRONTIUM-90 IN TAP WATER

Second Quarter 1960

Location	Month	Activity $\mu\mu$c/liter	Sr^{89}/Sr^{90} at midpoint of sampling month
Richmond, California (40 liters per sample)	April	0.264	0.3
	May	0.253	0.4
	June	0.265	0.1
New York City (100-200 liters per sample)	April	0.27	-
	May	0.59	-
	June	0.42	-

SECTION IV.—OTHER DATA

EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

Portable survey instruments are available at the stations of the Radiation Surveillance Network and one of their uses is to record external gamma radiation. These readings are not precise, especially for measurement of low levels but they can show the presence or absence of any significant increases above background. The differences among the values shown on the following table are within the variance anticipated due to differences in normal background and in instrument response characteristics.

TABLE 1.—EXTERNAL GAMMA ACTIVITY

Public Health Service Radiation Surveillance Network

July 1960

Station location	Average* mr/hr	Station location	Average* mr/hr
Alaska, Anchorage	0.01	Mississippi, Pascagoula	(**)
Alaska, Fairbanks	0.01	Missouri, Jefferson City	0.01
Alaska, Juneau	0.02	Montana, Helena	0.03
Arizona, Phoenix	0.01	New Jersey, Trenton	0.02
Arkansas, Little Rock	0.02	New Mexico, Santa Fe	0.04
California, Berkeley	0.01	New York, Albany	0.02
California, Los Angeles	0.01	North Carolina, Gastonia	0.02
Colorado, Denver	0.02	Ohio, Cincinnati	(**)
Connecticut, Hartford	0.02	Oklahoma, Oklahoma City	0.02
District of Columbia	0.02	Oklahoma, Ponca City	0.04
Florida, Jacksonville	0.02	Oregon, Portland	0.02
Georgia, Atlanta	0.02	Pennsylvania, Harrisburg	0.01
Hawaii, Honolulu	0.02	Rhode Island, Providence	0.02
Idaho, Boise	0.02	South Carolina, Columbia	0.02
Illinois, Springfield	0.01	South Dakota, Edgemont	(**)
Indiana, Indianapolis	0.01	South Dakota, Pierre	0.02
Iowa, Iowa City	0.02	Texas, Austin	0.01
Kansas, Topeka	0.02	Texas, El Paso	0.02
Louisiana, New Orleans	0.01	Utah, Salt Lake City	0.02
Maryland, Baltimore	0.02	Virginia, Richmond	0.01
Massachusetts, Lawrence	0.02	Washington, Seattle	(**)
Michigan, Lansing	0.02	Wyoming, Cheyenne	0.02
Minnesota, Minneapolis	0.01		

*Readings taken 3 feet above ground.
**No data received.

STRONTIUM-90 CONCENTRATION IN BREAD PURCHASED IN NEW YORK CITY

Health and Safety Laboratory
U. S. Atomic Energy Commission

The October 1960 issue of Radiological Health Data presented data on the concentration of strontium-90 in bread purchased in New York City for 1958, May 1959 and the first two months of 1960. The following table gives the data for March through June of 1960. One loaf of each type is purchased daily from a local grocer and the loaves composited on a monthly basis. Five brands are represented in each month's sample. No appreciable change in the strontium-90 concentration in whole wheat and white bread from January and February 1960 values is noted.

TABLE 1.—STRONTIUM-90 AND CALCIUM IN BREAD PURCHASED IN NEW YORK CITY

March-June 1960[1]

Sampling period	Calcium	Strontium-90		
	gm/kg of original material	μμc/gm Ca	μμc/kg of original material	μμc/daily intake[2]
	Whole Wheat Bread			
March	0.68	30	21	0.08
April	0.66	32	21	0.08
May	0.83	34	29	0.1
June	0.98	29	28	0.1
	White Bread			
March	0.74	13	9.5	0.44
April	0.73	13	9.6	0.44
May	0.88	13	11	0.51
June	1.30	7.8	10	0.46

[1]Data taken from Quarterly Summary Report, HASL-95, Dated October 1, 1960.
[2]Calculated values from U. S. Department of Agriculture data on average daily per capita consumption of 3.6 gm/day of whole wheat bread and 46.2 gm/day of white bread. (See Radiological Health Data, August 1960.)

ARGONNE NATIONAL LABORATORY SOIL DATA

U. S. Atomic Energy Commission

Dr. Philip F. Gustafson has reported further fission product radioactivity in soil samples at Argonne National Laboratory, Lemont, Illinois. Previous data were reported in Radiological Health Data, July 1960.

Isotope	May 13, 1960 mc/mi^2	June 30, 1960 mc/mi^2
Zr^{95} Nb^{95}.....	80	45
Cs^{137}.....	187	191
Ru^{106}.....	890	830
Ce^{144}.....	1,200	1,280
Totals.....	2,437	2,391
Dose-rate (μrad/hr)*	1.97	1.71

*Calculated dose-rate at one meter above ground surface. No correction is made for shielding effect of structures.

ENVIRONMENTAL LEVELS OF RADIOACTIVITY AT ATOMIC ENERGY COMMISSION INSTALLATIONS

The United States Atomic Energy Commission is providing data on environmental levels of radioactivity in the vicinity of major Commission installations to the Public Health Service on a quarterly basis. The data are from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

The November 1960 issue of Radiological Health Data summarized the 1959 and the first quarter of 1960 reports for seven of the installations. Reports for eight more installations for this same period are included in the following section.

ARGONNE NATIONAL LABORATORY

University of Chicago
Lemont, Illinois
Issued July 1960

Argonne National Laboratory (ANL) has made measurements of the radioactivity on the Laboratory grounds and in the area around the Laboratory since 1948. This is done primarily to determine if the work conducted at Argonne contributes to the natural radioactive content of the environment. The results of this program from 1948 through 1958 have been published annually in the form of Argonne National Laboratory Reports. This report gives the data on the amount of radioactive materials added to the environment in 1959 and in the first quarter of 1960 as a result of ANL operations.

Air samples were collected on the Argonne grounds and at four locations from 10 to 30 miles from the Laboratory and the radioactivity measured. No radioactivity originating at ANL was detected in any of the air samples.

Argonne National Laboratory waste water is discharged into Sawmill Creek, a small stream that runs through the ANL grounds and enters the Des Plaines River about 500 yards downstream from the waste water discharge. This is the only location off the Laboratory grounds where activity attributable to ANL operations was found. This activity consisted principally of uranium, uranium decay products and cobalt-58. During the period covered by this report the average uranium concentration in the Creek downstream from the waste water discharge was approximately 40 $\mu\mu$c per liter, or 0.2% of the maximum permissible concentration (MPC). The corresponding average for cobalt-58 was about 10 $\mu\mu$c

per liter, or 0.01% of the MPC. In addition, smaller amounts of plutonium and a few fission products were detected occasionally below the waste water discharge. The concentrations of these isotopes were also a very small fraction of the MPC.

The radioactivity in the Des Plaines River was measured at several locations above and below the mouth of Sawmill Creek to determine the effect of the creek on the radioactive content of the Des Plaines River. As a result of dilution, the activity in Sawmill Creek had no detectable effect on the radioactivity in the Des Plaines River.

TABLE 1.—AVERAGE RADIOACTIVITY IN AIR FILTER SAMPLES, 1953-59*

($\mu\mu c/m^3$)

Year	Alpha activity	Beta activity
1953.....	0.010	1.2
1954.....	.010	0.4
1955.....	.007	0.8
1956.....	.010	1.3
1957.....	.008	2.1
1958.....	.007	2.8
1959.....	.006	2.3

*From 1953 through 1956 samples were collected only on the Argonne site. Off-site air sampling was begun in 1957, and the results for 1957, 1958 and 1959 are the averages of samples collected both on and off the Argonne site.

TABLE 2.—RADIOACTIVITY IN AIR FILTER SAMPLES

(Average concentrations in $\mu\mu c/m^3$)

Activity	Calendar year 1959		First quarter 1960	
	On ANL site	Near ANL site	On ANL site	Near ANL site
Alpha.....	0.006	0.006	0.003	0.004
Beta.....	2.2	2.3	0.10	0.10

TABLE 3.—URANIUM AND PLUTONIUM IN SAWMILL CREEK, First Quarter 1960

(Average concentrations in $\mu\mu c$/liter)

Location	Total Beta*	Uranium	Plutonium
Above ANL site	7.0	2.1	<0.05**
Below waste water discharge...	49	126	0.3

*The beta activity added to the creek in Argonne waste water was almost entirely due to uranium daughters and cobalt-58.

**All of the samples analyzed from this location contained less than 0.05 $\mu\mu c$ of plutonium per liter. This value is the smallest amount that can be detected by the analytical method used.

BROOKHAVEN NATIONAL LABORATORY

Associated Universities, Incorporated
Upton, New York
Issued July 1960

Regular measurements have been made of the effect of operations on the environmental levels of radioactivity in the vicinity of Brookhaven National Laboratory (BNL) since the establishment of the Laboratory in 1947. This report presents data for 1959 and the first quarter of 1960.

Operations at BNL affect the natural radiation background in the vicinity of the Laboratory in two ways:

1. The cooling air from the research reactor contains a substantial quantity of argon-41 (half-life 110 minutes). This gas, present in a large volume of air, is released from a 300 foot high stack and is further diluted by the atmosphere. The effect of radioactive argon from the reactor stack during 1959 and first quarter 1960 is shown in table 1.
2. Liquid wastes produced by Laboratory operations contain a variety of radioactive substances at very low levels of activity. These wastes are filtered, chlorinated and released to a small stream that forms one of the headwaters of the Peconic River.

TABLE 1.—RADIATION LEVELS AT SITE BOUNDARY DUE TO LABORATORY OPERATIONS

(Average values in mr/week, from argon-41 in reactor cooling air)

Period	N. Gate*	S. W. perimeter	S. E. perimeter	N. E. perimeter
Calendar year 1959.....	0.46	0.22	0.39	0.84
First quarter 1960.....	0.22	.35	.69	.31

*This station is 680 meters inside the site boundary.

The limit recommended by the National Committee on Radiation Protection for radiation levels at the edge of the controlled area of a laboratory such as BNL is 10 milliroentgens per week, averaged over a year. Thus, the highest average level shown in table 1, i.e., 0.84 mr/week, is far below the permissible limit. The gross radiation level in this area as measured by the monitoring stations, averaged 3.8 mr/week during 1959 and 2.7 mr/week during the first quarter 1960. In each case, about 1.7 mr/week is due to natural radiation and the rest is due to fallout from nuclear weapons tests. It is pertinent to note that the station for which the highest value was obtained is located in the direction for which a maximum average level is to be expected from meteorological considerations.

The gross concentration and amount of radioactivity in the laboratory liquid waste effluent where it leaves the site, is shown in table 2.

TABLE 2.—LIQUID WASTE EFFLUENT LEAVING THE BNL SITE

Period	Volume gal/day	Concentration of activity $\mu\mu$c/liter	Total activity millicuries
Calendar year 1959.....	1,745,000	79	144
First quarter 1960.....	494,000	130	21

If the BNL waste effluent were to be used as drinking water, the applicable limit on the concentration, in accordance with the recommendations of the NCRP, would be 600 $\mu\mu$c/liter. However, the effluent is not used for drinking and undergoes considerable additional dilution as it progresses downstream. Thus, the concentration values shown in table 2 are relatively small compared to the permissible concentrations.

KNOLLS ATOMIC POWER LABORATORY

General Electric Company
Schenectady, New York
Issued July 1960

The Knolls Atomic Power Laboratory (KAPL) has been operated by the General Electric Company for the Atomic Energy Commission since 1946. The principal task of the Laboratory is to support the Commission's Naval Reactors Program in the development of atomic power reactors for naval propulsion. This task includes design, construction and prototype operation of nuclear power reactors.

The Knolls Atomic Power Laboratory consists of two sites, the Knolls Site and the West Milton Site. (See figure 1 for geographical locations.) The former is located 5 miles east of Schenectady, New York, on the south bank of the Mohawk River. It consists of approximately 170 acres, upon which are located administrative buildings; chemistry, physics, metallurgical, engineering, and radioactive materials laboratories; critical assembly buildings; machine shops; decontamination facilities; radioactive waste storage and processing facilities; nuclear fuel storage and assembly buildings. The West Milton Site is located approximately 18 miles north of Schenectady, in Saratoga County, occupying some 4,000 acres. Principal facilities include the Triton prototype reactor, equipment service building, fuel service building and waste treatment facility. In addition, there are administration and utility service buildings. There is also a containment-sphere in which a destroyer prototype reactor now is being constructed.

The Knolls Atomic Power Laboratory releases small amounts of radioactive materials both to the atmosphere and to two surface streams in the area, the Mohawk River at the Knolls Site and the Glowegee Creek at the West Milton Site. Prior to the release of this low level radioactivity to the environment, all KAPL liquid waste and exhaust air systems are carefully and continuously monitored. In addition to the in-plant control-monitoring, an environmental monitoring program is conducted both on and off-site at KAPL for the following purposes: (1) to audit the operational control of radioactive waste release to the environment and (2) to ascertain compliance with the standards established by the United States Atomic Energy Commission based on recommendations of the National Committee on Radiation Protection and Measurements (NCRP).

It has been the policy of the staff of the Knolls Atomic Power Laboratory to communicate with the Mohawk River Advisory Committee (MRAC) concerning KAPL operations as they affect waste disposal practices. The members of the MRAC are representatives of the New York State Health Department, the New York State Water Pollution Control Board and a sanitary engineering consultant.

KAPL environmental monitoring locations are given in the attached figure. A brief description of the types of samples collected at the various location is given in the referenced legend.

Liquid Radioactive Waste Disposal

West Milton Site

Because the Glowegee Creek does not have a reliable dilution potential, the radioactivity levels in the liquid waste from the West Milton Site are operationally controlled and diluted prior to release to the creek. Samples of Glowegee Creek water are taken once a week at two locations, 150 feet above and 2,640 feet below the point where the West Milton Site effluent enters the creek. The amounts of gross beta radioactivity discharged from the West Milton Site as well as the results of the river sampling are presented in table 1. Alpha analyses are not performed since no alpha radioactivity is discharged from the West Milton Site.

TABLE 1.—GROSS BETA RADIOACTIVITY DISCHARGED AND DETECTED IN THE GLOWEGEE CREEK

Quarter	Total waste discharged mc	Average concentration discharged μμc/liter	Average concentration in creek		Precipitation results μμc/liter
			Upstream μμc/liter	Downstream μμc/liter	
1959:					
First	4.8	1,500	46	42	2,170
Second	11.5	150	20	23	1,470
Third	23.2	200	23	31	310
Fourth	1.4	17	19	20	100
1960:					
First	0.6	28	28	18	159

The data in the table above corroborate the statement that the West Milton Site effluent did not adversely affect the levels of radioactivity detected in the Glowegee Creek. In addition, precipitation results have a variable effect upon the Glowegee Creek samples dependent upon the amount of rainfall, creek flow and the period of sampling relative to the period of precipitation.

Knolls Site

Based on hydraulic, hydrological and tracer studies of the Mohawk River basin by the United States Geological Survey in 1955, a decision was made by the AEC with the concurrence of MRAC to utilize in a limited degree the dilution potential of the Mohawk River for the disposal of low level radioactive liquid waste from the Knolls Site. All potential sources of liquid radioactive waste are connected to the collection tanks in the radioactive waste processing building. The release of liquid waste to the Mohawk River is regulated through the control and monitoring of concentrations of fission products in the collection tanks and control of the discharge rate of the effluent. Radioactive wastes with concentrations greater than 1.5×10^7 μμc/liter are not discharged to the river. For wastes with less activity, it has been determined that in-plant and river dilution will bring the concentration of all radioisotopes present to less than 1/10 the permissible concentrations for continuous exposure as specified by the NCRPM in NBS Handbook 69. A continuous, proportional sample of the Knolls Site combined sewer effluent is taken at the point of discharge to the Mohawk River. Analyses of weekly composite samples are made for radiochemical content and these analyses show that strontium-90 is the principal component which has to be considered in the waste control program. The radioactivity content of the Knolls Site waste effluent is given in table 2.

TABLE 2.—RADIOACTIVITY CONTENT OF THE KNOLLS SITE WASTE EFFLUENT

Radioisotope	Calendar year 1959		First quarter 1960	
	Percent abundance	Average concentration μμc/liter	Percent abundance	Average concentration μμc/liter
Ce^{144}, Pr^{144}	37.8	15,000	24.9	6,000
Sr^{89}	18.0	7,400	23.4	5,600
Sr^{90}	19.1	7,800	10.3	2,500
I^{131}	-	-	1.8	430
Ru^{106}	1.6	660	1.0	240
Cs^{137}	17.3	7,100	30.2	7,200
Zr^{95}, Nb^{95}	1.3	530	2.0	480
Total	95.1	-	93.6	-

Mohawk River water is sampled at locations upstream and downstream from the Knolls Site. The sampling locations are: (1) at the General Electric Company Powerhouse eight miles upstream from the Knolls Site (a continuous sample after May 1959), (2) at the point of discharge to the Mohawk River from the Knolls Site (a continuous sample), (3) at the Vischer Ferry Powerhouse approximately two miles downstream (a continuous sample) and (4) at the City of Cohoes Pumping Station approximately thirteen miles downstream (weekly grab sample). The following table shows the amounts of radioactivity discharged from the Knolls Site as well as the results of the Mohawk River water and precipitation sampling.

TABLE 3.—GROSS BETA RADIOACTIVITY DISCHARGED AND DETECTED IN THE MOHAWK RIVER*

(Average concentrations in μc/liter)

Quarter	Total waste discharged (millicuries)	Average concentration discharged	Upstream	Downstream			Precipitation
			GE powerhouse	Vischer Ferry	Cohoes**		
					Raw	Treated	
1959:							
First	4,459	130,000	(***)	36	44	26	950
Second.....	294	11,000	3	20	20	12	920
Third.....	687	8,900	15	7	5	9	90
Fourth.....	2,530	19,000	6	4	18	9	190
1960:							
First.....	2,295	24,000	6	4	11	5	65

*Knolls Site effluent is monitored continuously for alpha radioactivity; data are not reported for brevity. The average annual discharge rate was less than 1 percent of the most restrictive environmental limit for alpha (Pu 329).

**Cohoes samples are once a week grab samples, therefore they are less representative than the samples collected upstream.

***Prior to sampling.

Environmental Airborne Radioactivity

Air-cleaning equipment is an essential element of exhaust systems servicing areas capable of generating airborne radioactive wastes. At KAPL there are twelve exhaust systems which require air-cleaning equipment. These ventilation systems are non-recirculating; ten of which contain a glass wool prefilter and a Cambridge or CWS absolute filter. The air-cleaning system for the special materials machine shop uses a high velocity air supply connected to a cyclone separator unit with a glass wool filter. Another method of air cleaning at KAPL is the activated charcoal system used in the Radioactive Materials Laboratory. Air is exhausted through a glass prefilter and a high efficiency absolute filter prior to passing through the activated charcoal filters. In all cases the exhaust stacks are monitored continuously for radioactive materials to assure proper functioning of air cleaning systems.

Environmental airborne radioactivity is measured at three locations on the Knolls Site, five locations on the West Milton Site and at the General Electric Company Research Laboratory, approximately one mile west of KAPL-Knolls Site. Airborne radioactivity is sampled continuously and analyzed on a weekly basis. Each environmental monitoring station is equipped with film dosimeters to detect integrated gamma radioactivity levels. The averaged results of the airborne radioactivity analyses are given in the following table.

TABLE 4.—GROSS BETA AIRBORNE RADIOACTIVITY *

(Average concentrations in uuc/m^3)

Quarter	Knolls Site	West Milton	Off-Site
1959:			
First.....	1.36	1.73	1.55
Second.....	1.52	2.45	2.10
Third.....	1.21	.30	.73
Fourth.....	.44	.39	.81
1960:			
First.....	0.21	0.19	0.26

* Measurements of airborne radioactivity are made at least 48 hours after collection to allow naturally occurring short half-life radioactive material to decay.

Conclusions

As a result of the environmental monitoring program conducted by the Knolls Atomic Power Laboratory at both the Knolls Site and the West Milton Site, it is concluded that the operations at these installations did not adversely affect the radioactivity levels of the local environment.

FIGURE 1

1. Glowegee Creek sampling station 150 feet upstream from the entrance of the West Milton Site effluent. Samples of Glowegee Creek water are collected weekly during the warmer seasons.
2. West Milton Site—Environmental radiation levels and particulate airborne radiation levels are sampled continuously at five geographically placed locations on the Site. Precipitation is sampled continuously.
3. Glowegee Creek sampling station 2,640 feet downstream from the West Milton Site. Samples of Glowegee Creek water are collected weekly.
4. General Electric Powerhouse, about eight miles upstream from the Knolls Site; Mohawk River water is sampled continuously.
5. General Electric Laboratory, 4,000 feet west of the Knolls Site, has a continuously operating radiation-level detector and air monitor for particulate airborne materials.
6. Knolls Site environmental particulate air and radiation levels are sampled continuously at three stations at different geographic locations. In addition, precipitation, continuous and proportional samples of combined sewer effluent are collected. Samples of soil and vegetation are collected periodically.
7. Mohawk River water is sampled continuously at the Vischer Ferry Powerhouse which is approximately two miles downstream from the Knolls Site.
8. Cohoes is approximately thirteen miles downstream from the Knolls Site. Samples of untreated Mohawk River water and the Cohoes drinking water are collected weekly.

NATIONAL REACTOR TESTING STATION

Health and Safety Division, Idaho Operations Office
Atomic Energy Commission
Idaho Falls, Idaho

Issued July 1960

The remoteness of National Reactor Testing Station facilities practically eliminates the possibility of any significant direct radiation exposures to the neighboring population. However, trace amounts, well below the maximum permissible limits for the various isotopes,[1] are dispersed into the natural environment. Both liquid and gaseous wastes containing a very low level of radioactivity are disposed of daily at the National Reactor Testing Station.

The Health and Safety Division collects and analyzes a large number of water, air, milk, and rabbit bone samples as part of their constant monitoring program. The attached table presents the data collected for 1959 and the first quarter of 1960.

In many cases it can be seen that the data have to be presented as being less than a certain value. This is very important in that many times it is not economically feasible or practical to develop analytical procedures beyond their ability to determine adequately that the amount being analyzed is insignificant. The value stated in these cases represents the present detection limit for that particular measurement.

An example of NRTS interpretation of environmental water values follows:

> "The activity is measured at equal to or less than 150 micromicrocuries of beta activity per liter of water (analytical detection limit). Knowing that strontium-90 will contribute less than 25 percent of any total fission product activity if detected, the 150 $\mu\mu$c/liter detection limit assures us that any strontium-90 contribution would be less than 45 micromicrocuries per liter, or well below the maximum permissible concentration for this isotope. Further efforts to quantize the activity contribution from natural radioactive elements (i.e., uranium and thorium) have not been necessary since our detection limit is sufficiently low to allow adequate evaluation of the radioactivity in potable water supplies."

The monitoring of the environs for airborne radioactivity has been qualitative with a back-up capability of activating additional samplers by radio signal to collect quantitative data. Although the back-up stations have been activated on occasion when on-site releases were known to have occurred, no significant values were recorded.

Rabbit bones are sampled and analyzed as an evaluation of the up-take and concentration strontium-90 in a biological system. Since the jack rabbit lives completely on the open environment as opposed to man who eats washed and prepared food and since his metabolic function may be entirely different, the amount of strontium-90 concentrated in the bones is ten to twenty times higher than that found in human bones. The amount of strontium-90 found in control rabbits taken from an area under minimum influence of any activity originating on the National Reactor Testing Station is seen to be very near that of rabbits on the perimeter of the site and predominantly down wind from the National Reactor Testing Station facilities. The amount of strontium-90 detected in all off-site samples to date is due to fallout from past weapons tests in locations remote from the NRTS.

Iodine-131 being a gaseous fission product and highly mobile lends itself to being a most sensitive indicator for environmental monitoring. Milk samples from environmental cows are routinely analyzed for the presence of this isotope. Again, the values in table I are lower than the detection limit which is suitable for detecting any biologically significant amount of I^{131} in the sample.

The off-site monitoring film data for 1959 consists of intermittent testing in preparation for a continuous program which has been put into effect to provide data starting the second quarter of 1960. Two high values were recorded, but since a duplicate film at the same location read less than 20 mrem, these were concluded to be invalid since both films should agree within the limits of experimental error if the exposure had been real.

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[1]National Bureau of Standards Handbooks 59 and 69.

TABLE 1.—ENVIRONMENTAL MONITORING DATA

Sample	Number of stations	Approximate frequency	Calendar year 1959			First quarter 1960		
			Number of samples	Alpha	Beta	Number of samples	Alpha	Beta
Off-site ground water	27	Bimonthly	110	<3 μμc/liter	<150 μμc/liter	39	<3 μμc/liter	<150 μμc/liter
On-site production well water	16	Weekly	607	<3 μμc/liter	300 μμc/liter	162	3.1 μμc/liter	<150 μμc/liter
Off-site air	20	Biweekly		(**)		(**)	(**)	
Perimeter rabbit bones (Jack Rabbit)	5	Quarterly	10	20 μμc/gm Ca*		10	20.1 μμc/gm Ca*	
Off-site control rabbit bones (Jack Rabbit)	1	Monthly	17	17 μμc/gm Ca*		4	20.3 μμc/gm Ca*	
Off-site milk (I^{131})	24	Monthly	237	γ <1000 μμc/liter		70	γ <1000 μμc/liter	
Off-site monitoring badges	19	Intermittent	76	β <20 mrem/90 days γ <20 mrem/90 days		19	β <20 mrem/90 days γ <20 mrem/90 days	

*Analyses for Sr^{90} in rabbit bones will lag by one calendar quarter. This data is for the 4th Quarter 1959.
**Qualitative only.

OAK RIDGE NATIONAL LABORATORY

Union Carbide Nuclear Company
Oak Ridge, Tennessee

Issued May 1960

Radioactive waste materials arising from the operation of atomic energy installations at the Oak Ridge National Laboratory are collected, treated and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to earthen pits located in the Conasauga shale formation. Low level liquid wastes are discharged, after preliminary treatment, to the surface streams.

Air that may have become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by filters, scrubbers and/or precipitation.

Air Monitoring

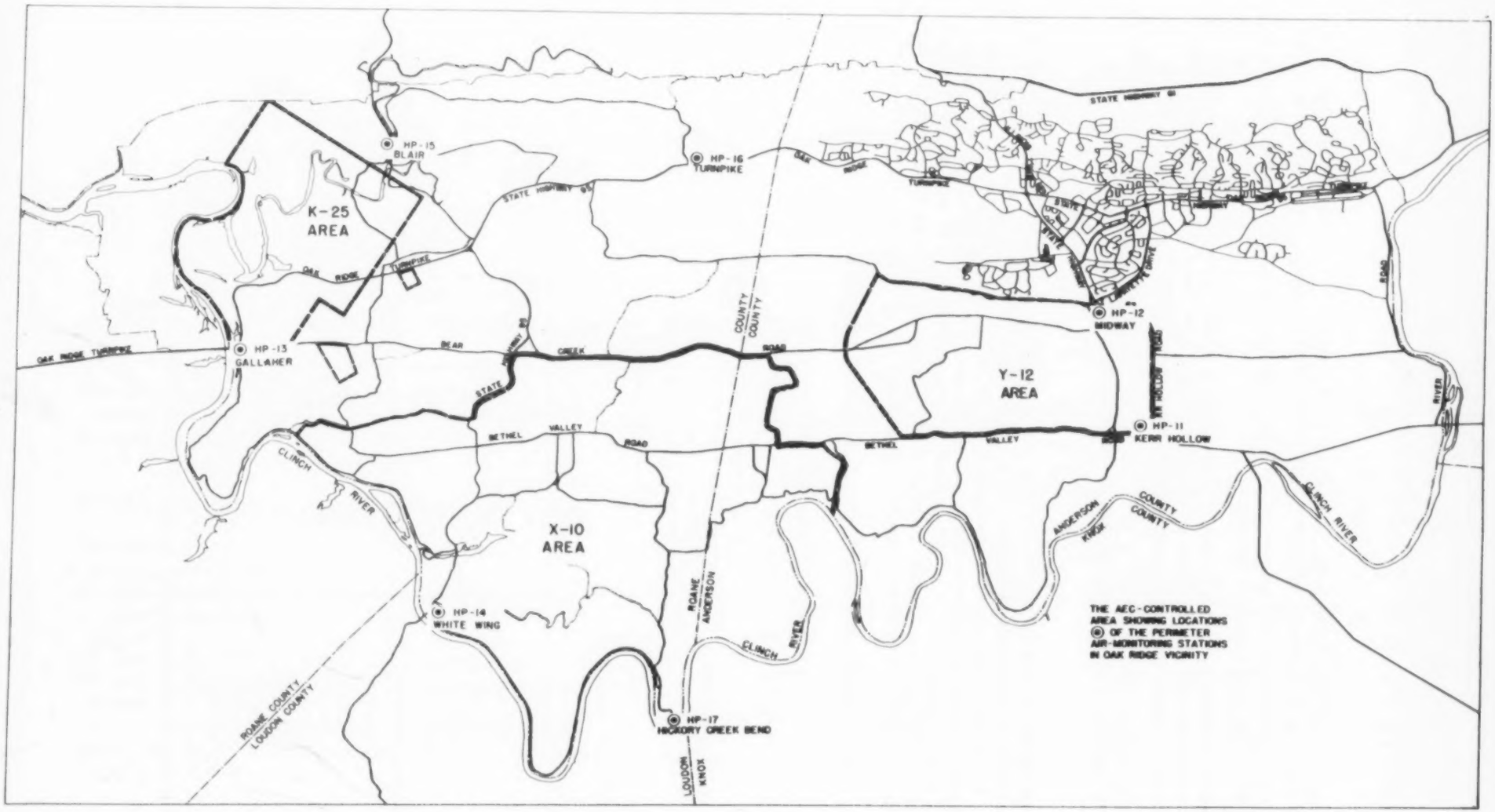
Atmospheric contamination and fall-out occurring in the general environment of east Tennessee are monitored by two systems of monitoring stations. One system consists of seven stations which encircle the plant areas (fig. 1) and provides data for evaluating the impact of all Oak Ridge operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 120 miles (fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Table 1 presents the data from the air monitoring program for 1959 and the first quarter of 1960.

TABLE 1.—CONTINUOUS AIR MONITORING FILTER DATA

(Average concentrations in $\mu\mu c/m^3$)

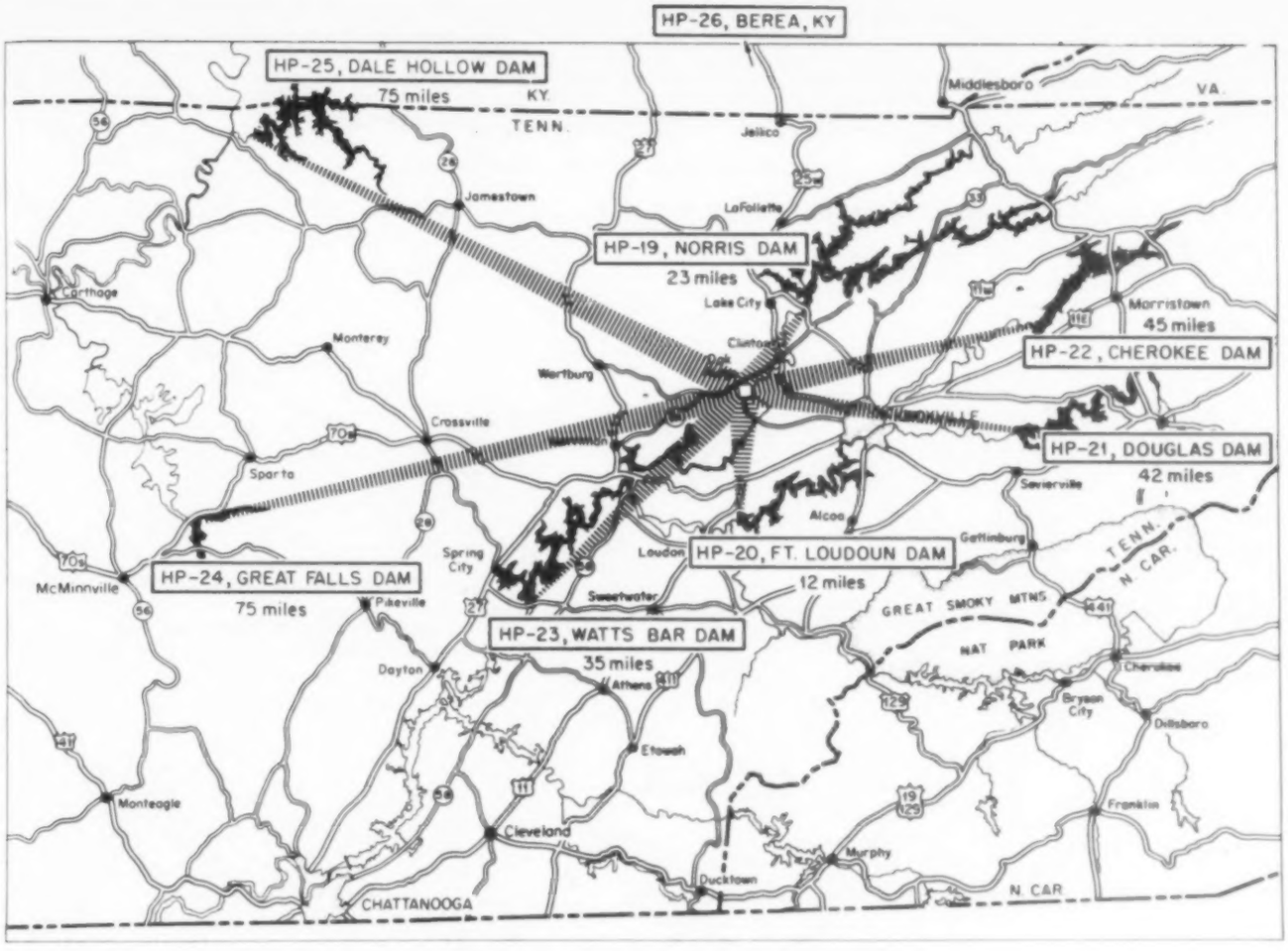
Station number	Calendar year 1959		First quarter 1960	
	Number of samples	Gross activity	Number of samples	Gross activity
Perimeter stations:				
HP-11	52	1.577	13	0.113
HP-12	49	1.629	13	.098
HP-13	52	1.663	13	.106
HP-14	52	1.1130	13	.090
HP-15	52	1.997	13	.131
HP-16	52	1.348	13	.099
HP-17	52	1.686	13	.121
Remote stations:				
HP-19.	52	2.373	13	.124
HP-20	52	2.211	13	.117
HP-21	37	1.091	13	.107
HP-22	39	1.601	13	.132
HP-23*	29	0.513	13	.125
HP-24*	26	.253	13	.119
HP-25	46	1.804	13	.109
HP-26	52	1.377	13	.080

*Stations in operation only during latter half 1959.



PERIMETER AIR MONITORING STATIONS

FIGURE 1



STATION SITES FOR REMOTE AIR MONITORING SYSTEM

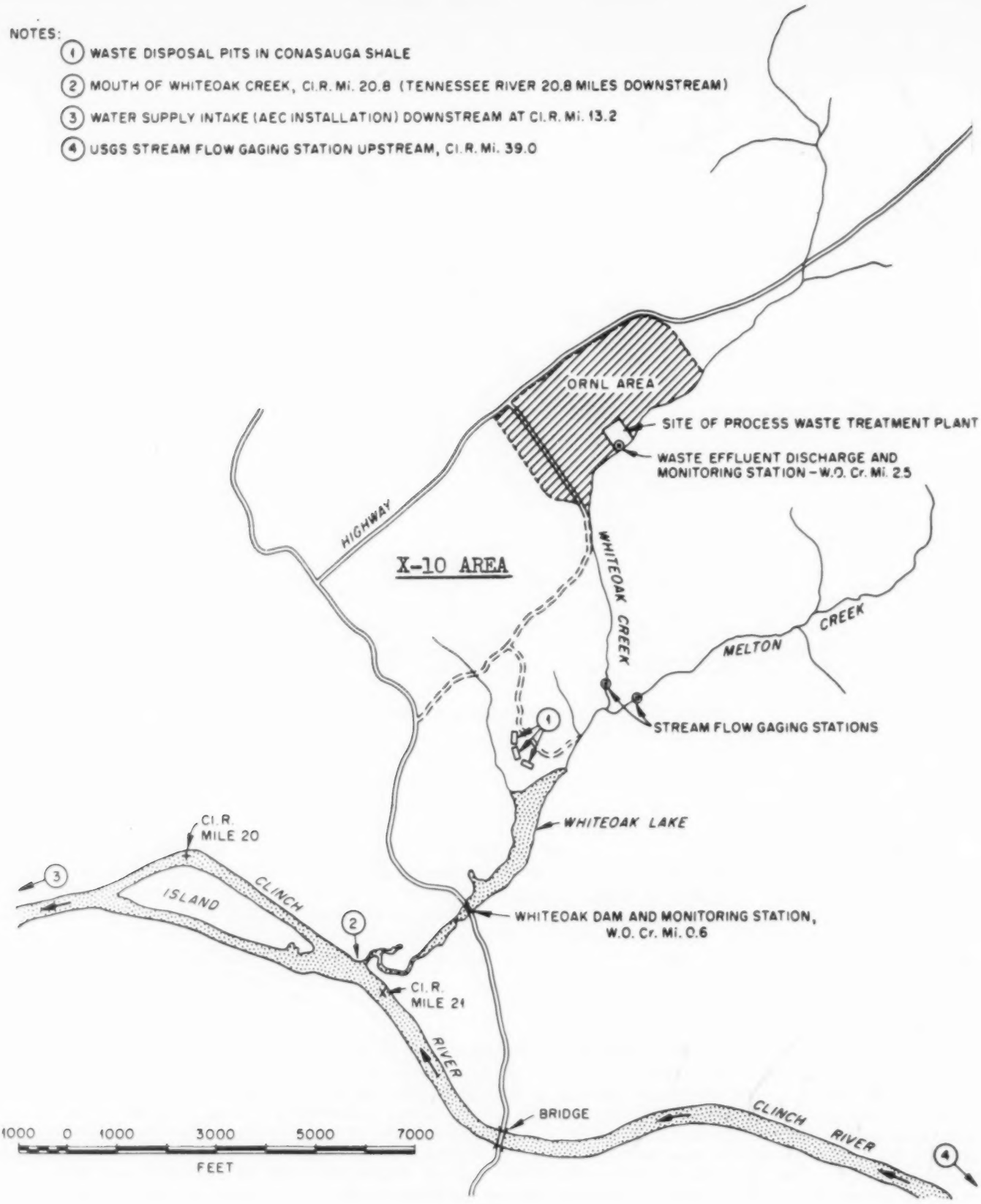
FIGURE 2

Air contamination levels during the first half of 1959 were a factor of 4 to 6 times greater than the average for the entire year. By the end of 1959, air contamination levels had decreased to approximately 1/5 the value given for the yearly average. Specific analysis for fission products and decay studies indicated that the high levels experienced during the first part of the year were due to the world-wide fall-out from weapons testing. The low values for remote stations 23 and 24 resulted from the fact that these stations were in operation only during the latter half of 1959 and do not reflect the higher fall-out levels experienced during the first half of the year.

Water Monitoring

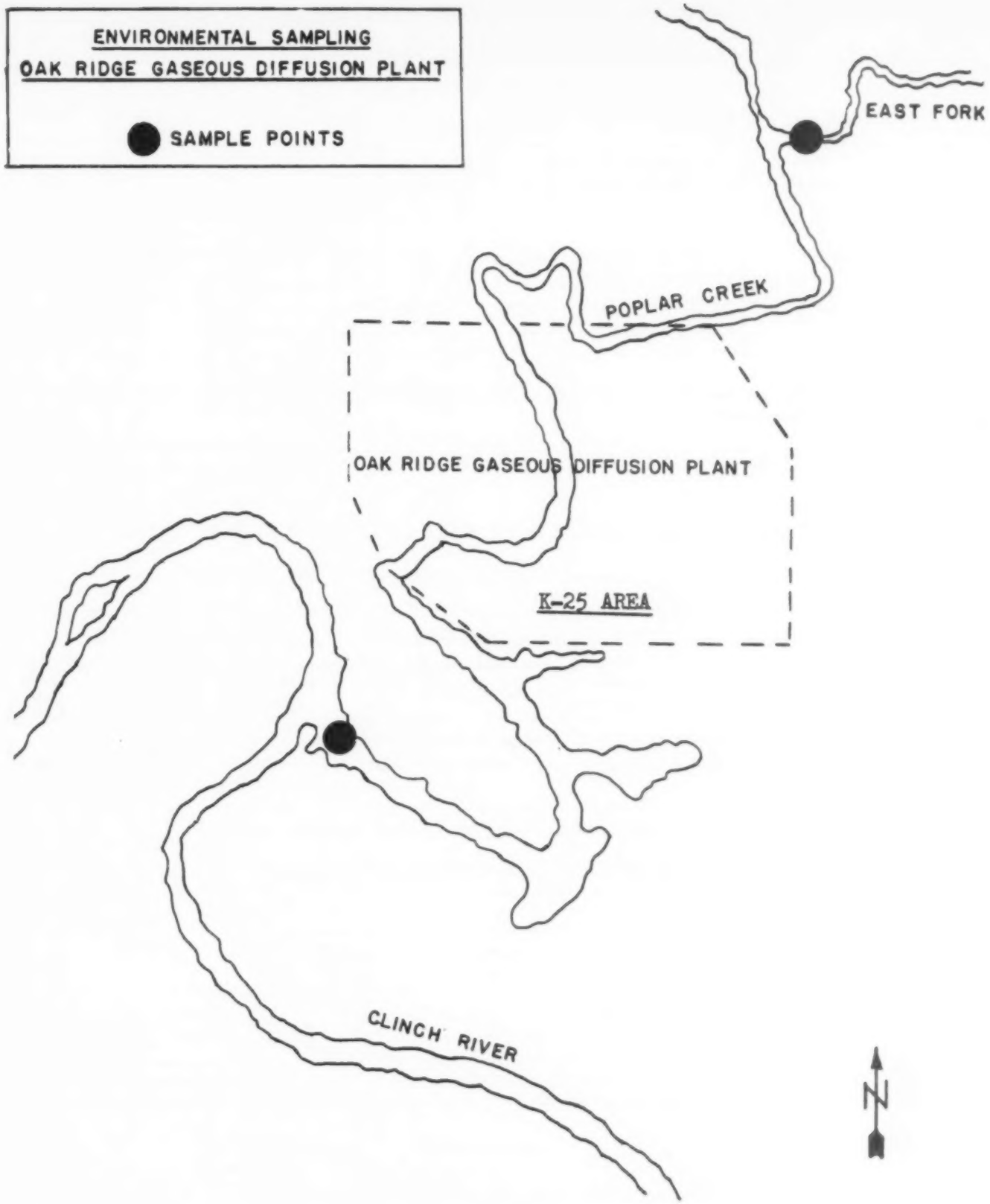
Large volumes of low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and then to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population in the neighborhood of a controlled area as recommended by the National Committee on Radiation Protection (NCRP). The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in figs. 3 and 4. Samples are taken in Poplar Creek and White Oak Creek and at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously by the United States Geological Survey to obtain dilution factors for calculating the probable concentrations of wastes in the river. Water monitoring data is tabulated in tables 2 and 3.


NOTES:
(1) WASTE DISPOSAL PITS IN CONASAUGA SHALE
(2) MOUTH OF WHITEOAK CREEK, Cl.R. Mi. 20.8 (TENNESSEE RIVER 20.8 MILES DOWNSTREAM)
(3) WATER SUPPLY INTAKE (AEC INSTALLATION) DOWNSTREAM AT Cl.R. Mi. 13.2
(4) USGS STREAM FLOW GAGING STATION UPSTREAM, Cl.R. Mi. 39.0
ORNL AREA
SITE OF PROCESS WASTE TREATMENT PLANT
WASTE EFFLUENT DISCHARGE AND MONITORING STATION - W.O. Cr. Mi. 2.5
HIGHWAY
X-10 AREA
WHITEOAK CREEK
MELTON
CREEK
STREAM FLOW GAGING STATIONS
WHITEOAK LAKE
Cl.R. MILE 20
ISLAND
CLINCH
WHITEOAK DAM AND MONITORING STATION, W.O. Cr. Mi. 0.6
Cl.R. MILE 21
RIVER
BRIDGE
CLINCH RIVER
1000 0 1000 3000 5000 7000
FEET

ORNL LOCATION MAP

FIGURE 3



WATER SAMPLING LOCATIONS

FIGURE 4

TABLE 2.—MAJOR RADIOACTIVE ELEMENTS IN THE CLINCH RIVER

(Average concentrations in μμc/liter)

Location	Sampling period	Sr^{90}	Ce^{144}	Cs^{137}	$Ru^{103-106}$	Co^{60}	Total
Upstream (mi. 37.5)	10/1/59-1/29/60	1.1	1.0	(*)	(*)	(*)	4.5
	-	-	-	-	-	-	-
Pt. of Entry (mi. 20.8)**	12/28/58-12/27/59	20.0	15.0	19.0	74	18	310
	12/28/59-3/27/60	6.7	16.2	14.8	447.5	34.5	1032
Downstream (mi. 4.5)	10/23/58-11/3/59	18.6	5.4	5.3	11.4	2.3	49
	11/4/59-1/27/60	9.1	3.6	4.1	696.8	8.6	775

*None detected.

**Values given for this location are calculated values based on the levels of waste released and the dilution afforded by the river.

TABLE 3.—CONCENTRATION OF RADIOACTIVITY IN POPLAR CREEK

(Average concentrations in μμc/liter)

Location	Calendar year 1959			First quarter 1960		
	Number of samples	Uranium	Gross beta	Number of samples	Uranium	Gross beta
Upstream (East Fork)	52	62	180	13	44	356
Downstream (Outfall)	52	6	220	13	5	747

Normal Sampling Frequency: Continuous sampling composited over one week.

Table 4 presents the results of the radioactivity in rain water sampling.

TABLE 4.—RADIOACTIVITY IN RAIN WATER

(Average concentrations in μμc/liter)

Station number	Calendar year 1959		First quarter 1960	
	Number of samples	Gross activity	Number of samples	Gross activity
Perimeter station:				
HP-11	44	722	11	54
HP-12	44	630	11	56
HP-13	44	610	11	44
HP-14	43	653	11	30
HP-15	39	578	11	43
HP-16	44	882	11	53
HP-17	43	814	11	48
Remote stations:				
HP-19	45	1126	11	71
HP-20	49	1465	11	53
HP-21	31	386	11	60
HP-22	33	441	11	46
HP-23*	23	132	11	58
HP-24*	21	141	11	83
HP-25	41	802	12	52
HP-26	44	1014	12	99

*Stations in operation only during latter half of 1959.

External Gamma Activity

External gamma radiation levels are measured monthly at five locations in the Oak Ridge area. Measurements are taken with a GM survey instrument at a distance of three feet above ground. The results are tabulated in table 5.

TABLE 5.—EXTERNAL GAMMA RADIATION LEVELS

(Average levels in mr/hr)

Period	Location				
	Solway Gate	Y-12 East Portal	Newcomb Road Oak Ridge	Gallaher Gate	White Wing Gate
Calendar year 1959	0.024	0.019	0.021	0.027	0.027
First quarter 1960	.017	.015	.014	.022	.017

External gamma radiation levels in the Oak Ridge area do not differ significantly from the average of the levels measured throughout the United States by the Public Health Radiation Surveillance Network.

PADUCAH GASEOUS DIFFUSION PLANT

Union Carbide Nuclear Company
Paducah, Kentucky

Issued July 1960

Waste disposal operations at the Paducah Gaseous Diffusion Plant, operated by the Union Carbide Nuclear Company, are concerned exclusively with uranium. The problem does not involve highly radi-

oactive waste materials such as those associated with reactor operations. Most of the waste at this plant originates from the cleaning of process equipment. In addition to this, small quantities escape to the atmosphere in the form of uranium hexafluoride.

Figure 1 is a map of the Paducah Plant and the immediate vicinity showing the tributaries to the Ohio River which receive the liquid effluents from the plant, and the locations where monitoring of the drainage water is performed. The solids waste pit and cylinder storage yard for uranium hexafluoride are also shown.

The environmental monitoring program consists of a continuing system for sampling the air at four stations around the plant perimeter fence, the water at two locations in the Big Bayou Creek, one in Little Bayou Creek and four in the Ohio River. The results of this monitoring are presented in tables 1 and 2.

TABLE 1.—GROSS STREAM WATER ACTIVITY

Location	Type of analysis	Calendar year 1959			First quarter 1960		
		Number of samples	Average uuc/liter	Percent MPC*	Number of samples	Average uuc/liter	Percent MPC*
Big Bayou leaving Gov't. Land	Uranium	55	47.3	0.24	12	36.3	0.18
	Gross Beta		392	2.0		1,476	7.38
Big Bayou at Ogden Bridge Road	Uranium	12	15.8	0.08	3	7.4	0.04
	Gross Beta		377	1.9		415	2.08
Little Bayou	Uranium	53	281	1.4	12	307	1.54
	Gross Beta		9,120	46		13,470	67.8
Ohio River above Paducah Plant	Uranium	19	2	< 0.01	4	< 2	< 0.01
	Gross Beta		101	0.51		130	0.65
Ohio River—South Side at Joppa	Uranium	15	2	< 0.01	4	< 2	< 0.01
	Gross Beta		161	0.81		157	0.78
Ohio River—Middle at Joppa	Uranium	15	2	< 0.01	4	< 2	< 0.01
	Gross Beta		369	1.8		147	0.74
Ohio River—below Paducah Plant	Uranium	12	6.1	0.03	4	< 2	< 0.01
	Gross Beta		119	0.6		176	0.88

*The values for MPC in water are 1/10 of the MPC allowed for continuous occupational exposure as given in Handbook 69, National Bureau of Standards, issued June 5, 1959.

TABLE 2.—GROSS AIR ACTIVITY

Year	Number of samples	Type of analysis	Average of 4 sampling points $\mu\mu c/m^3$	Percent MPC*
1959.....	102	Gross Alpha	0.311	16
	85	Gross Beta	2.07	0.21
1960—First quarter..	32	Gross Alpha	0.15	7
	32	Gross Beta	1.9	0.2

*The values for MPC in air are 1/10 of the MPC allowed for continuous occupational exposure as given in Handbook 69, National Bureau of Standards, issued June 5, 1959.

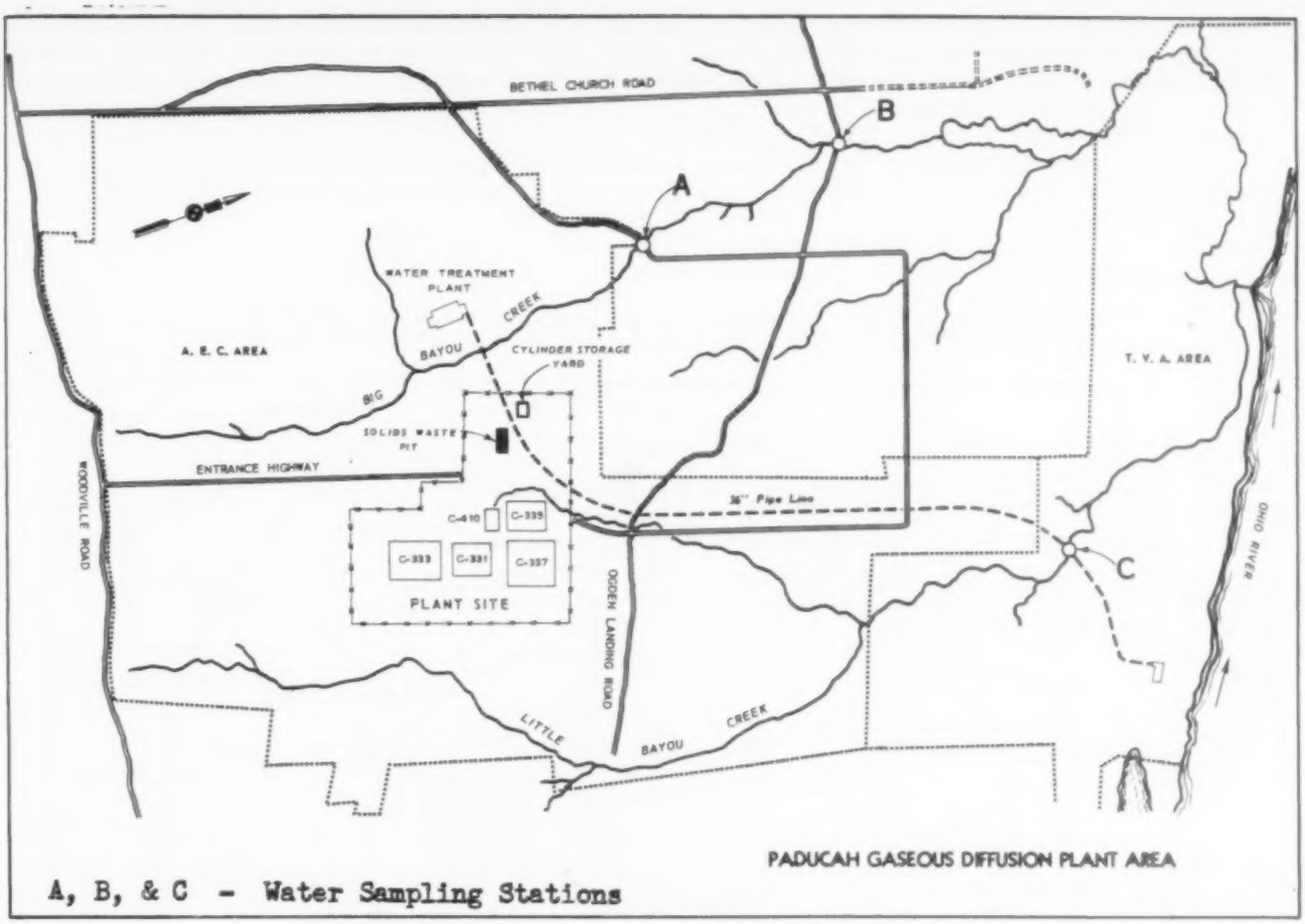


FIGURE 1

SAVANNAH RIVER PLANT

E. I. du Pont de Nemours Company
Aiken, South Carolina

Issued July 1960

The Savannah River Plant maintains a continuous monitoring program to determine the concentrations of radioactive materials in a 1,200 square-mile area outside the Plant perimeter. Included are parts of Aiken, Barnwell and Allendale Counties, South Carolina, and Richmond, Burke and Screven Counties, Georgia. This program, initiated in 1951, prior to start-up of Plant operations, is carried out by the Health Physics Section of the du Pont Company, prime contractor for operation of the plant for the Atomic Energy Commission.

The concentrations of radioactive materials found during 1959 and the first quarter of 1960 in the environs of the Savannah River Plant through release of radioactive wastes by the Plant were so small that in most cases they could not be definitely distinguished from that due to natural background radiation or to debris from past weapons tests.

Atmospheric Monitoring

Air and rainwater samples are collected continuously at thirteen monitoring stations which are spaced around the Plant in two concentric circles such that a significant Plant release of radioactivity to the air would be detected regardless of prevailing wind conditions (see figure 1). Five monitoring stations are located on the inner circle which follows, within a few miles, the Plant boundary (Plant Perim-

eter locations). The outer circle circumscribes an area extending approximately 25 miles from the center of the Plant and has eight monitoring stations (25 mile radius locations). The basic purpose of the two concentric routes is to determine whether the Plant has contributed radioactivity to the atmosphere. An average radioactivity level at the Plant Perimeter, which is substantially higher than that observed at the 25 Mile Radius, would be indicative of a Plant contribution. Small differences in average radioactivity levels, however, are attributed to both the non-uniformity of fallout and to statistical variation of the analyses. The average concentrations, which show plant contributions to be negligible, are shown in table 1.

SAMPLE COLLECTION ROUTES

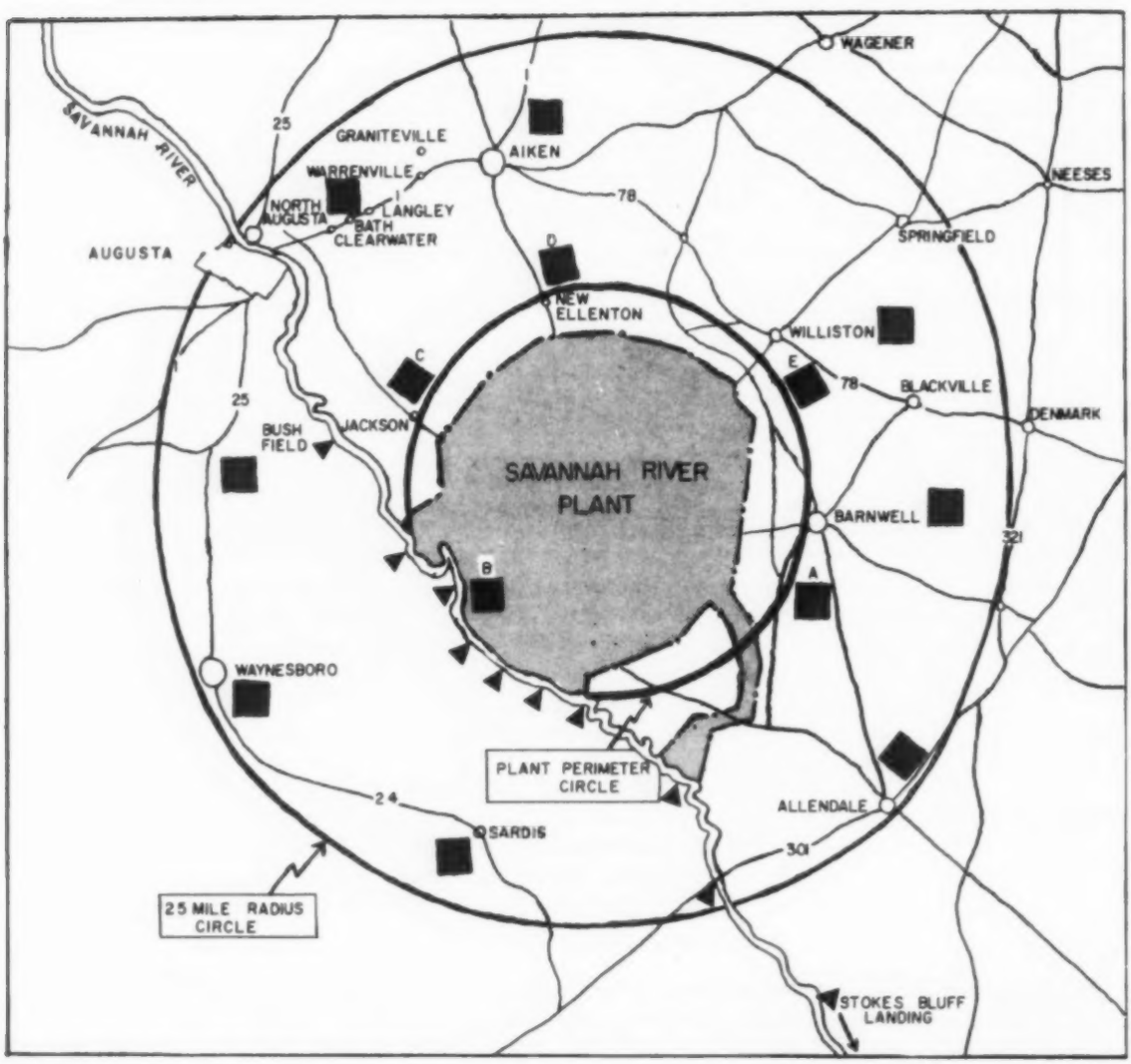


FIGURE 1

PRINT IN BIND

TABLE 1.--GROSS RADIOACTIVITY IN AIR

(Average concentrations in $\mu\mu c/m^3$)

Location	Calendar year 1959			First quarter 1960		
	Alpha	Nonvolatile Beta	Radio-iodine	Alpha	Nonvolatile Beta	Radio-iodine
Plant Perimeter	0.001	3.8	0.09	0.0012	0.17	0.04
25 Mile Radius	0.001	3.0	0.05	0.0009	0.12	0.04

TABLE 2.--GROSS RADIOACTIVITY IN RAINWATER

(Average concentrations in $\mu\mu c$/liter)

Location	Calendar year 1959			First quarter 1960		
	Alpha	Nonvolatile Beta	Radio-iodine	Alpha	Nonvolatile Beta	Radio-iodine
Plant Perimeter	0.6	230	19	0.6	86	32
25 Mile Radius	0.5	310	16	0.5	106	31

Water Monitoring

The communities in the vicinity of the Savannah River Plant obtain their sanitary water from deep wells or small surface streams. The results from the water samples collected monthly in fourteen surrounding towns are essentially the same as those observed prior to the startup of the Savannah River Plant in 1951. The average concentrations measured during the quarter are presented in table 3.

TABLE 3.--RADIOACTIVITY IN PUBLIC WATER SAMPLES

(Average concentrations in $\mu\mu c$/liter)

Period	Alpha	Nonvolatile Beta
Calendar years 1951-52	1.2	6
Calendar year 1959	0.9	9
First quarter 1960	0.7	7

Approximately 120 miles downstream from the plant, the city of Savannah processes water from Abercorn Creek for industrial and sanitary consumption. This creek is largely Savannah River water with some swamp drainage. Savannah is the only municipality that uses river water downstream from the plant. Radioactivity in the river adjacent to the Plant may be seen to be slightly higher than at other locations, but is hardly significant when compared to maximum permissible concentration levels. Greater than 85 percent of the radioactivity released to the river was neptunium-239 which has a 2.3 day half life. Downstream, the radioactivity decrease resulted from decay of short-lived radionuclides and the natural ion-exchange capacity of the river bed. The average concentrations observed at each of the three general sampling locations are listed in table 4.

N BINDING

TABLE 4.—RADIOACTIVITY IN SAVANNAH RIVER WATER

(Average concentrations in μμc/liter)

Location	Calendar year 1959				First quarter 1960			
	Alpha	Nonvolatile Beta	H^3	Sr^{90}	Alpha	Nonvolatile Beta	H^3	Sr^{90}
3 miles above above Plant	0.4	17	4,000	0.66	0.4	7	4,000	0.6
Plant Boundary	.4	36	-	-	0.9	32	-	-
10 miles below Plant	.4	21	11,000	1.27	0.4	18	6,000	1
60 miles below Plant	.4	23	8,000	-	0.4	13	5,000	-

Although a slight plant contribution is noted, the radioactive content is well below the maximum permissible concentration levels of the NCRP.

Vegetation and Food Monitoring

Radioactive materials which are air-borne may deposit on plants and soil. Those that deposit directly on food and forage plants contaminate them by remaining attached to the surfaces of the above-ground parts, or by absorption into leaves and stems. Radioactive material in soil may be absorbed through the root system and then enter the plant's metabolism. Vegetation (Bermuda grass) samples were collected weekly at 14 locations along the Plant perimeter and at 14 locations along the 25-mile radius route. The availability of Bermuda grass at most locations on the sampling routes and its importance as a pasture grass were the primary reasons for its choice as the sampling species. As indicated by the close correlation in table 5 between the radioactivity found in vegetation along the plant perimeter and that found on the 25-mile radius route, the radioactivity on the vegetation in the environs of the Savannah Plant is the result of weapons test fallout.

TABLE 5.—RADIOACTIVITY IN BERMUDA GRASS SAMPLES

(Average concentrations in μμc/gm*)

Location	Calendar year 1959			First quarter 1960		
	Alpha	Nonvolatile Beta	Radio-iodine	Alpha	Nonvolatile Beta	Radio-iodine
Plant Perimeter	0.13	140	1.0	0.22	46	1.5
25 Mile Radius	.16	190	.8	.27	38	1.3

*Dry weight.

An approximate two-fold increase in the concentration of nonvolatile beta emitters and radioiodine was observed during March, which appeared to be associated with weapons test debris.

Milk from dairies and farms in Aiken, North Augusta, Snelling, Talatha and Langley, South Carolina was analyzed weekly for radioiodine (principally iodine-131) and tritium content. The average radioiodine concentration in the 313 samples collected during 1959 and the first quarter of 1960 was less than the minimum sensitivity of the analysis which is equivalent to 25 percent of the NCRP maximum permissible concentration. The average tritium concentration was approximately 2 percent of the maximum permissible concentration.

The concentration of strontium-90 in milk produced locally is determined once per quarter. The average concentration detected in local milk samples during 1959 and the first quarter of 1960 was less than 50 percent of the maximum permissible concentration. This level is essentially the same as that

detected in milk obtained from the Atlanta, Georgia milkshed[1] during 1959 (17.1 μμc/l) and is attributed entirely to the accumulation of strontium-90 fallout from previous nuclear weapons tests.

The determination of radioactivity concentrations in algae is important because they are well known concentrators of specific radioactive materials and because of their relationship in the food chain of aquatic organisms. Indigenous algae, primarily green ***(Vaucheria)*** and blue-green ***(Phormidium)***, were collected weekly upstream, adjacent to, and downstream from the Plant. The results are shown in table 6.

TABLE 6.--RADIOACTIVITY IN SAVANNAH RIVER ALGAE

(Average concentrations in μμc/gm*)

Location	Nonvolatile Beta Emitters	
	Calendar year 1959	First quarter 1960
3 miles above Plant	60	-
At Plant Boundary	110	48
10 miles below Plant	83	53
60 miles below Plant	60	-

*Dry weight.

Fish (predominantly bream and catfish, the edible species) were collected weekly above, adjacent to, below the Plant. The average nonvolatile beta concentrations measured in the edible portion (flesh) are given in table 7.

TABLE 7.--RADIOACTIVITY IN FISH FLESH

(Average concentrations in μμc/gm*)

Location	Nonvolatile Beta Emitters	
	Calendar year 1959	First quarter 1960
3 miles above Plant	5	4
At Plant boundary	5	5
10 miles below Plant	5	-
60 miles below Plant	5	3

* Wet weight.

General Conclusion

Monitoring of domestic water supplies, fish and milk in the vicinity of the plant has in no case shown levels of radiation that are of special significance from a health standpoint.

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[1]Monthly Reports, U. S. Department of Health, Education, and Welfare, Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

SHIPPINGPORT ATOMIC POWER STATION

Duquesne Light Company
Beaver County, Pennsylvania

June 1, 1960

Environmental levels of radioactivity at the Shippingport Atomic Power Station for 1959 were reported in the July 1960 issue of Radiological Health Data. The following report presents a summary of the data for the first quarter of 1960.

The Shippingport Atomic Power Station is the first large scale nuclear power electric generating station and is operated for the Atomic Energy Commission by the Duquesne Light Company. During this quarter, the plant was undergoing refueling for the first time since operation began in December 1957. After more than 5,800 hours of full power operation, part of the reactor fuel required replacement. Because of refueling, the reactor was not operating during this period and the chief wastes produced were those from the laundry from washing protective clothing used by the workers, and decontamination operations on plant apparatus.

An environmental radiation survey of Shippingport and the surrounding area was initiated by the AEC in January of 1956 prior to operation of the plant. Since Shippingport began operation in December 1957, the survey has been continued as a check on the rigid plant controls and design features that insure that the amounts of radioactivity released are limited. The results of the environmental radiation survey have shown that the controls and design features have been completely adequate to minimize radioactivity released to the environment.

The liquid and gaseous discharges from Shippingport are controlled so that concentrations do not exceed those recommended by the National Committee on Radiation Protection (NCRP). The Duquesne Light Company as operator of the Shippingport Atomic Power Station has a permit from the State of Pennsylvania to discharge limited amounts of liquid wastes to the Ohio River. The limits imposed by the State are designed to insure that permissible concentrations recommended by the NCRP and Pennsylvania Regulation 433 will not be exceeded.

Liquid Wastes

The radioactive liquid wastes discharged during the first quarter of 1960 are summarized below. The average concentrations shown in the table are in addition to normal background radioactivity in the condenser cooling water used for dilution in the effluent channel. The condenser cooling water is river water that is pumped through the turbine-generator plant condenser.

TABLE 1.—SUMMARY OF GROSS RADIOACTIVITY RELEASED TO OHIO RIVER

Period	Total per month μc	Average per day μc	Average concentration in effluent channel during release μμc/liter
1960			
January	22,746	750	6.7
February	21,332	701	5.8
March	22,908	754	4.9

The maximum total discharge in one day during the quarter was 3,453 microcuries. No tritium was released during the quarter.

River water samples are taken continuously at four locations upstream and downstream from Shippingport and analyzed weekly. The upstream sampling stations are at the Phillips Power Station of the Duquesne Light Company (about 20 miles upstream) and at the cooling water intake at Shippingport. The downstream continuous sampling stations are on the water intake lines of the water treatment plants at Midland, Pennsylvania and East Liverpool, Ohio, approximately one and eight miles downstream respectively. In addition, grab samples are collected weekly from the Ohio River at U. S. Corps of Engineers Lock and Dam No. 7, about one mile downstream. Table 2 shows this data.

TABLE 2.—GROSS RADIOACTIVITY CONCENTRATIONS IN THE OHIO RIVER DURING FIRST QUARTER 1960

(Average concentrations in μμc/liter)

Station	Number of samples	Suspended	Dissolved	Total
Upstream:				
Phillips	12	3.8	5.2	9.0
Shippingport Intake ..	12	5.0	5.8	11
Downstream:				
Midland	12	4.8	7.8	13
E. Liverpool	12	3.0	7.8	11
Dam No. 7.....	12	4.8	5.1	9.9

Analyses of each river water sample include a measurement of potassium-40. This radioactive isotope is the principal radioactive material that occurs naturally in the environment. During the quarter the average concentration of potassium-40 in the water was found to be 3.6 μμc/liter.

In addition to the routine gross radioactivity analyses of composite weekly samples, three Ohio River grab samples were collected during the quarter and determinations made on a number of specific radioactive isotopes of interest. Samples were collected upstream and downstream from Shippingport on March 9, 1960, and at Wheeling, West Virginia on March 14, 1960. The results of these analyses are summarized in the table below. It should be pointed out that the numerical results under the isotope headings marked with an asterisk(*) indicate upper limits for that isotope than the absolute value for the species. Other radioactive isotopes of similar chemical characteristics are present and the results actually indicate the total concentration of a group of chemically similar radioactive isotopes. For example, the results for strontium-90 also include strontium-89 and possibly other similar radioactive materials of lesser importance.

TABLE 3.—CONCENTRATION OF RADIOISOTOPES IN THE OHIO RIVER DURING FIRST QUARTER 1960

(Average Concentrations in μμc/liter)

Station	Strontium-90*	Cobalt-60*	Cesium-137*	Iron-59*	Tritium	Potassium-40
Upstream	1.0	1.9	0.1	6	0	2.5
Downstream	1.0	1.2	0.1	5	0	2.5
Wheeling, W. Va.	0.4	1.2	0.2	0	0	2.8

Area Monitoring

During the first quarter of 1960, four monitoring stations were used to continuously monitor and record background levels of beta-gamma radiation and levels of airborne particulate radioactivity in the vicinity of the Shippingport site. The data recorded by each station during this period were checked and tabulated on a weekly schedule.

The plant incinerator used for burning contaminated combustible material was operated intermittently during the quarter. The exhaust from the incinerator passes through a wet gas scrubber and a filter and is monitored at the stack exit during operation to determine the quantity of particulate radioactivity discharged. During the first quarter of 1960, the maximum particulate radioactivity monitored was 46 $\mu\mu c/m^3$. This concentration is less than the maximum permissible concentration for off-site airborne particulate radioactivity of 100 $\mu\mu c/m^3$ as recommended by NCRP.

TABLE 4.—AIRBORNE PARTICULATE RADIOACTIVITY

(Average concentrations in $\mu\mu c/m^3$)

Period	Station			
	SE of Main Building	1/2 mi. SW of site	1/2 mi. NW of site	1/2 mi. NE of site
First quarter 1960	0.691	0.625	0.795	1.57

TABLE 5.—BETA-GAMMA BACKGROUND RADIATION LEVELS

(Average values in millirad/hour)

Period	Station			
	SE of Main Building	1/2 mi. SW of site	1/2 mi. NW of site	1/2 mi. NE of site
First quarter 1960	0.014	0.015	0.012	0.011

Fallout

Radioactive fallout was collected at four of the area monitoring stations. Samples are collected from each station weekly and represent a sample period of one week. The following table indicates the data obtained from analyses of samples collected at these stations during the first quarter of 1960.

TABLE 6.—BETA RADIOACTIVITY IN FALLOUT DURING FIRST QUARTER 1960

(Average concentrations in $mc/mi^2/mo$)

Station	Number of samples	Activity
Upwind:		
1/2 mi. SW of Site	7	6.7
1/2 mi. NW of Site	13	9.0
Downwind:		
SE of Main Building.....	13	7.5
1/2 mi. NE of Site	13	7.5

The prevailing wind direction at Shippingport is generally from West to East. Data from the upwind stations are compared to that from the downwind stations in an effort to determine any effect from the plant. The above results reveal no significant differences that would indicate a contribution from the plant to the radioactive fallout. Fallout that is routinely monitored is attributed to past weapons testing.

General Conclusion

As a result of the environmental monitoring program conducted by the Shippingport Atomic Power Station, it is concluded that the operations at this station did not adversely affect the radioactivity levels of the local environment.

STRONTIUM-90 CONTENT OF ANIMAL FODDERS

Food and Drug Administration

The latest results by the Food and Drug Administration of their analyses of animal fodders for strontium-90 content is presented in table 1. Various fodders from nine states were collected by Food and Drug Inspectors and analyzed in their Washington laboratories. The May 1960 issue Radiological Health Data presented earlier data on strontium-90 in animal forage. Table 2 compares the strontium-90 content of hay and alfalfa with that of corn silage. The hay and alfalfa show a significantly larger amount of strontium-90 than the corn silage.

TABLE 1.--STRONTIUM-90 CONTENT OF ANIMAL FODDER

Food and Drug Administration

Source		Product	Date collected	Sr^{90} $\mu\mu c/kg$
State	County			
Idaho	Bonner	Ensilage	10/21/59	225
		Orchard Grass Timothy Hay	10/21/59	1,167
	Boundary	Silage	10/21/59	152
		Chopped Alfalfa Hay	10/21/59	251
Minnesota	Becker	Timothy & Alfalfa Hay	10/13/59 1959 crop	502
		Corn Silage	10/13/59 "	28
	Clay	Corn Silage	10/13/59 "	30
	Wilkin	Corn Silage	10/13/59 "	29
Missouri	Camden	Alfalfa Hay	11/3/59	35
		1/2 Corn & 1/2 Sorghum	11/3/59	20
	Pulaski	Corn Silage	11/3/59	482
		Lespedeza Hay	11/3/59	617
	Laclede	Prairie Hay	11/3/59	732
		Corn Silage	11/3/59	45
	Hickory	Lespedeza Hay	11/4/59	635
	Dallas	Lespedeza Hay	11/4/59	875
		Sorghum Silage	11/4/59	49
	Webster	Red Clover Hay	11/4/59	147
	Wright	Corn Silage	11/4/59	138
		Lespedeza Hay	11/4/59	776
New York	Schoharie	Sorghum Silage	10/20/59	38
		Alfalfa & Timothy Hay	10/20/59	176
		Corn Silage	10/20/59	114
	Montgomery	Corn Silage	10/21/59	221
		Timothy Hay	10/21/59	355
	Schenectady	Corn Silage	10/21/59	100
		Timothy Hay	10/21/59	698
	Albany	Corn Silage	10/23/59	83
		Clover & Timothy Hay	10/23/59	225
North Dakota	Cass	Alfalfa Hay	9/14/59 1959 crop	300
		Corn Silage	9/14/59 "	19
	Ransom	Corn Silage	10/14/59 "	80
		Alfalfa Hay 3rd Cutting	10/14/59 "	297
Ohio	Pike	Soy Beans (Sown 5/20/59)	(Harvested 11/15/59)	27
		Bulk Corn Silage (Sown 5/1/59)	(Harvested 7/20/59)	42
		Bulk Alfalfa Hay (Sown 1956 or 1957)	(Harvested 7/1/59)	400

TABLE 1.--STRONTIUM-90 CONTENT OF ANIMAL FODDER--Con.

Food and Drug Administration

Source		Product	Date collected	Sr^{90} $\mu\mu c/kg$
State	County			
Ohio--Con.	Warren	Bulk Alfalfa & Red Clover Silage	(Sown 3/58) (Harvested 5/59)	267 302
		Bulk Hay, Red Clover & Alfalfa Hay	(Harvested 5/59)	
	Clinton	Bulk Orchard Grass & Clover Silage	(Sown-1957) (Harvested 6/59)	166
		Bulk Clover & Timothy Hay	(Sown-2/58) (Harvested 6/59)	377
	Fayette	Bulk Corn Silage	(Sown 5/59) (Harvested 8/59)	21
		Bulk Timothy & Clover Hay	(Sown 1958 & Spring 1959) (Harvested 6/59)	365
	Ross	Bulk Orchard Grass, Ladino Clover & Alfalfa Silage	(Sown 1956 or 1957) (Harvested 6/15/59)	151
		Bulk Alfalfa Hay	(Harvested 6/15/59)	170
	Brown	Grass Ensilage	(Harvested 6/59)	510
South Dakota	Codington	Alfalfa Hay	9/16/59	450
	Deuel	Alfalfa Hay	9/17/59	267
Washington	Spokane	Ensilage, Alfalfa 1/2	10/21/59	188
		Alfalfa Hay & 1/2 Grass	10/21/59	233
	Stevens	Ensilage	10/22/59	285
		Oat Hay	10/22/59	73
		Alfalfa Hay	10/22/59	530
	Pend Orielle	Ensilage	10/23/59	105
		2/3 Alfalfa Hay 1/3 Grass	10/23/59	83
	Lincoln	Ensilage, Chopped Alfalfa	10/23/59	95
		Alfalfa Hay	10/23/59	221
Wisconsin	Walworth	Hay	11/13/59	504
		Corn Ensilage	9/22/59	34
	Jefferson	Alfalfa Hay	(Harvested 10/59)	305
		Corn Silage	(Harvested 10/5/59)	20
	Rock	Alfalfa Hay	11/4/59	412
		Corn Silage	11/4/59	49

TABLE 2.--COMPARISON OF STRONTIUM-90 CONCENTRATION IN ANIMAL FODDER BY STATES DURING 1959

State	Alfalfa, Hay Grass		Corn silage	
	No. samples	$\mu\mu c$ Sr^{90}/kg	No. samples	$\mu\mu c$ Sr^{90}/kg
Idaho	2	709	-	-
Minnesota	1	502	3	29
Missouri	7	545	5	147
New York	4	364	5	111
North Dakota	2	299	2	50
South Dakota	2	359	-	-
Ohio	9	303	2	32
Wisconsin	3	407	3	34
Washington	6	203	-	-
Weighted average	36	376	20	82

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